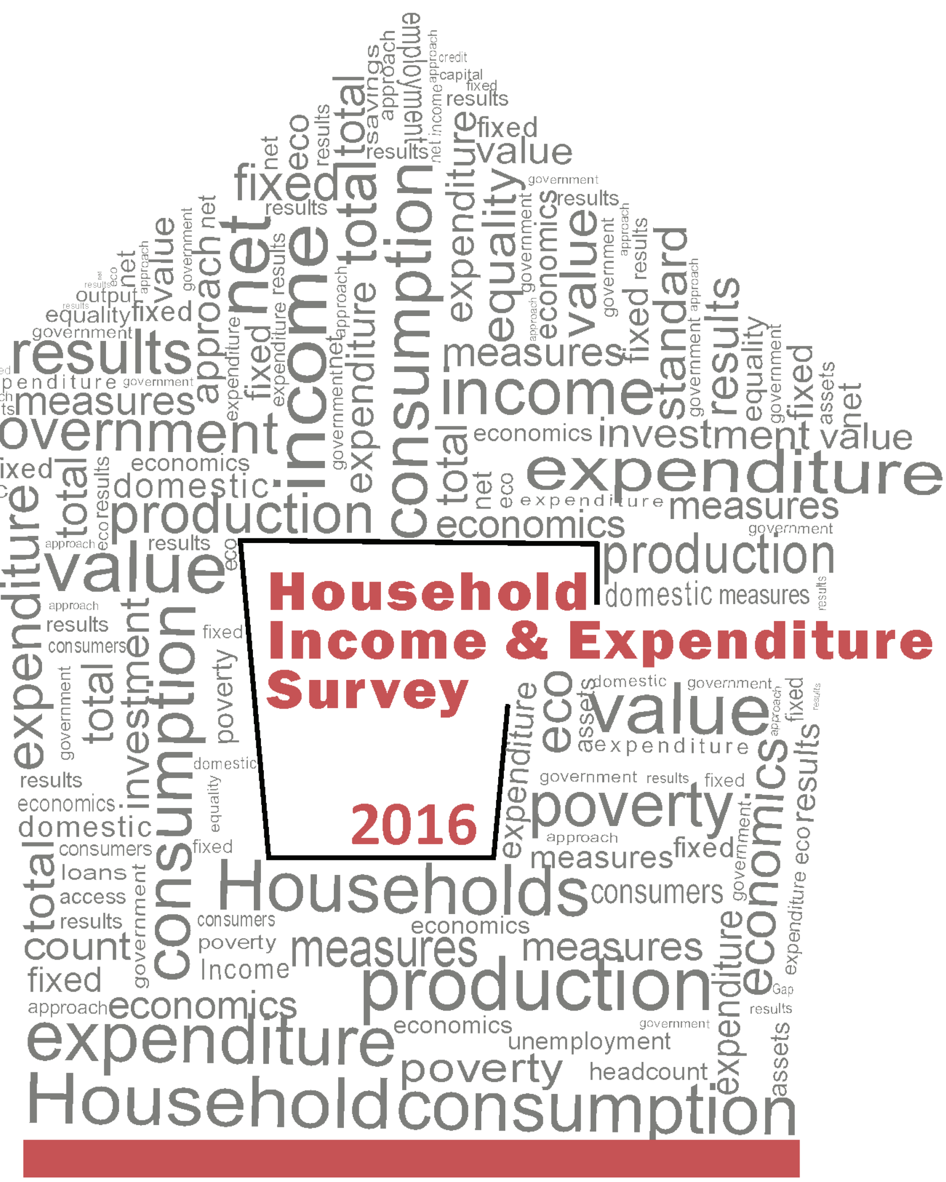
National Bureau of Statistics
Ministry of Finance & Treasury
Male', Maldives

Poverty measurement methodology

IN THE MALDIVES



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Poverty measurement methodology in the Maldives[1]
Technical report
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National Bureau of Statistics
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1 This report was prepared by a team including Christina Wieser (Economist, Poverty and Equity Global Practice), Giovanni Vecchi (Professor of Economics, University of Rome) and Giulia Mancini (PhD Candidate in Economics, University of Rome).

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1.INTRODUCTION

The Maldives National Bureau of Statistics (NBS) undertook a Household Income and Expenditure Survey (HIES) in 2016. The latest round of HIES in the Maldives (with other rounds conducted in 2003 and 2009-10) was undertaken by NBS with a completely revised survey and questionnaire design which includes important survey improvements to bring the HIES up to international standards, particularly in the measurement of poverty, but also hinders comparability with past survey years. The survey, for the first time, is representative at the Atoll level sampled 4,910 households (26,453 individuals) across 21 Atolls.

The analysis was undertaken in various steps which included the processing of the raw dataset and data validation. Subsequently, the consumption aggregate was constructed which consists of four components: (i) food expenditure; (ii) non-food, non-durable expenditure; (iii) durables; and (iv) rent. All expenditure items are aggregated at the household level and the resulting nominal consumption aggregate is adjusted for (i) differences in purchasing power due to differences in price levels across the Maldives (spatial deflation), using a survey-based Paasche index and (ii) within-the-year inflation, using a monthly CPI covering the survey period to produce a real consumption aggregate. Given data challenges, a decision was made of setting the poverty line as Maldives has set it in the past, using a relative poverty line.

This document focuses on the detailed description of the methodology in the Maldives which was applied to derive poverty estimates, including a discussion on data challenges. In particular, this document is organized as follows. Section 2 describes the processing of raw datasets and data validation. Section 3 displays the four components of the nominal consumption aggregate—expenditure on food, non-food non-durables, consumer flows from durable goods, and rent. Section 4 discusses temporal and spatial adjustments to construct a real consumption aggregate and section 5 provides an overview of data challenges. Section 6 discusses the construction of relative poverty lines and section 7 concludes.

Unprocessed NBS datasets are referred to as "raw" in the rest of this document. The expression "processing of raw datasets" is used here to mean a set of activities including renaming and labeling of variables and values, but also various transformations (e.g., string to numeric variables). A most important objective is the association of each question in the questionnaire to its correspondent variable(s) in the Stata datasets[2] . The aim is to cast the data in a format suitable for the analysis in subsequent stages.

In this section, we discuss a selection of checks that were implemented with the HIES raw datasets. We focus on four broad categories of tests: (i) Range checks; (ii) Internal consistency checks; (iii) Outlier detection; and (iv) Other data quality checks such as on age expansion factors, and kilocalorie intake.

2 Note that no check on whether the content of the variables is correct is carried out at this stage. The only priority is to make sure that Stata raw datasets contain what they are expected to contain.

2.1 RANGE CHECKS

Range checks aim at ensuring that provided values are within allowable minima and maxima. For instance, we check that the variable recording responses to question 1.5, "Who are the regular members who eats and sleeps in this household? Gender" only takes integer values 1 (for "Female") and 2 ("Male"), which are the allowed response codes.

A second type of check refers to **numeric versus string variables**. A most important module is Form 7 (consumption). If we take the consumption in the past 7 days, we expect question 3.7, "What was the quantity of (ITEM) consumed in the last seven days?", to be numeric. Similarly, we check that all quantities reported in form 7 are stored as numeric variables.

A third type of check refers to **missing values**. We count missing values (either in absolute terms or as a percentage of the total number of observations) and try to understand if any pattern exists (in which case further investigation is needed), or if they can be assumed to be missing at random.

Range checks have been designed and implemented systematically, on a variable-by-variable basis throughout the questionnaire.

2.2 INTERNAL CONSISTENCY CHECKS

Internal consistency checks are intended to ensure that the information provided by the respondents contains no inconsistencies. Typically, these checks involve different variables across different modules.

Consider Form 4 (individual form), question 8 ("What is your relationship with the head of the household?"), for instance. If someone is a "Spouse", then their response to question 27 ("What is your marital status?") must be 2 ("married"). Ideally, one should design and implement as many internal consistency checks as possible.

2.3 OUTLIER DETECTION

The term "outlier" is used here to denote an observation that appears to deviate markedly from other observations in the sample. Most methods found in the literature hinge on the underlying distribution of the data. The idea, in a nutshell, is to "normalize" the variable (that is, to transform the original variable to get its empirical distribution as close as possible to a standard Normal distribution), set one or more cutoffs, and flag as outliers those observations that are beyond the cutoffs, that is, too distant from the mean/median/center of the normalized distribution.

The method applied in the case of the Maldives is one suggested by Deaton and Tarozzi (2001). Their method consists in classifying as outliers those observations whose logarithms exceeded the mean of logarithms by more than 2.5 standard deviations:

(1) $(\ln(x_h)-\text{mean}[\ln(x_h)])/\text{std}[\ln(x_h)] > 2.5$

The drawbacks of this method are, in short, that it a) does not account for outliers on the left tail of the distribution (that is, for values that are "too small"), and b) uses the mean and the standard deviation, even though both measures are not robust statistics: they are affected by the very problem they are meant to eliminate, that is, extreme values.

We introduced a modified Deaton and Tarozzi procedure in equation (1) which has been applied in a number of countries. We suggest to a) take the median instead of the mean, and the interquartile range (IQR) instead of the standard deviation, and b) to take the absolute value of the transformed variable. The advantage of a) is a robustification of the procedure: the use of robust statistics (the median and the IQR) increases the resilience of the method to the presence of data contaminants. The advantage of b) is that the use of the absolute value allows us to flag extreme values in both the left and the right tail of the distribution (that is, we spot both too small and too large values):

(2) $|(\ln(x_h)-\text{median}[\ln(x_h)])/\text{IQR}[\ln(x_h)]| > 2.5$

When the focus is on inequality and poverty measurement, three points are worth mentioning. Let us consider the case of consumption quantities and expenditures.

First, prior to applying equation (2), quantities are converted into a common **measurement unit**, namely grams. This operation is non-trivial, as the 2016 HIES questionnaire allows households to report their food consumption using a multiplicity of non-standard units ("pieces", "cups", etc.). A detailed discussion of the way we tackle this issue is in section 3.1.

Second, most variables can be cleaned only after they have been expressed in **per capita terms.** Should one use total instead of per capita household expenditure, for instance, one would end up identifying as outliers (extremely large values) an abnormally high share of observations associated to large households. A symmetric mistake would affect the identification of "bottom outliers" (too small values), typically associated to small households.

Third, an outlier is a relative concept, and as such it has to be identified relatively to homogeneous population subgroups. We identify outliers, separately by Male vs. Atolls (two subgroups) and, where relevant, like in the case of reported quantities, by source (that is, whether items are consumed or purchased). Outliers identified by the algorithm are then **replaced with the median** within the stratum.

The variables cleaned using the outlier detection algorithm describes above are: quantities reported in the food consumption module (Form 7); monetary amounts reported for food purchases (Form 7); and unit values computed from the previous two variables (MVR per gram, for each recorded purchase – see section 3.1 for more details on the computation of unit values). The results of the procedure for the case of quantities are shown in Table 2.1. Overall, the number of detected outliers is not exceedingly large, neither at the item level nor overall (less than 1 percent of the total of observations for quantities in Form 7 are flagged and replaced).

Table 2.1: Outlier detection of standardized quantities (grams/household/week)

COICOP	item name	mean	median	mean after cleaning	N obs	N top outliers	N bottom outliers	N outliers/ n obs (%)
Purchased								
114201	Processed low fat milk	1,856	1,000	2,001	299	1	45	15.4
114304	Horlick and similar	564	450	376	25	2	1	12.0
111603	Rice Flour	1,640	1,000	1,509	43	2	0	4.7
119401	Soup sachets	158	100	127	22	1	0	4.6
116802	Dates- Dried/ Unspecied	1,053	545	743	186	4	4	4.3
116706	Passion fruit	809	655	778	72	1	2	4.2
122302	Tang Juice & alike	645	500	550	441	16	2	4.1
112101	Frozen Beef	3,816	1,000	1,355	76	1	2	4.0
111605	Corn Flakes	367	150	226	333	11	2	3.9
118403	Chocolate crumpy, Peanut butter/ Nutella	483	350	445	423	5	11	3.8
121201	Tea leaves/ Green Tea	218	200	187	897	14	16	3.3
112401	Fresh/Frozen Chicken	1,876	1,400	1,861	1,777	10	46	3.2
114501	Cheese/ including cream cheese	776	500	722	255	5	3	3.1
116201	Bananas	3,521	1,000	1,393	1,058	24	9	3.1
118602	Diabetic Sugar	256	100	174	100	3	0	3.0
Consumed								
COICOP	item name	mean	median	mean after cleaning	N obs	N top outliers	N bottom outliers	N outliers/ n obs (%)
116705	Pineapple	1,200	953	1,059	89	5	3	9.0
112602	Luncheon Meat	731	280	360	57	1	2	5.3
117312	Mixed fresh vegetables	1,159	1,000	1,189	136	1	6	5.2
113406	Thelli faiy/ Masfaiy	203	113	209	1,400	0	59	4.2
117201	Cabbage	624	500	606	50	1	1	4.0
111605	Corn Flakes	251	150	249	453	3	13	3.5
117603	Green peas canned	567	397	562	182	1	4	2.8
112405	Sausage	563	340	542	1,148	8	23	2.7
111602	Whole Wheat Flour	1,425	1,000	1,343	618	3	12	2.4
111301	Spaghetti/ Pasta/ Maccroni	769	500	724	1,113	13	14	2.4
111402	Faaroshi, hikki banas	1,363	400	1,105	722	12	5	2.4
111204	Marie Biscuits	576	300	446	605	8	6	2.3
119201	Salt	240	147	222	4,280	15	81	2.2
111101	Normal Rice	4,452	3,514	4,316	4,091	9	69	1.9
117307	Egg Plant, Bashi	1,212	1,000	1,241	476	0	9	1.9

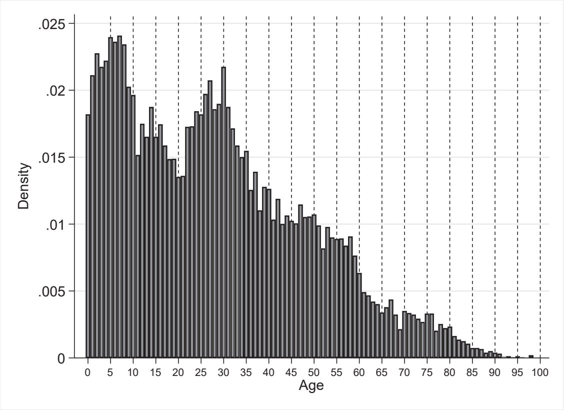
Source: Authors' own estimation based on HIES 2016 data.
Note: The first 15 items ordered by % of detected outliers out of the total number of observations for that item (last column), for both purchased and consumed items. Items with a sample size smaller than 20 are not displayed.

A fourth type of check for data quality aims at gaining insight into overall data quality. We focus on three variables, namely a) the age reported by the households for each member, b) expansion factors, and c) consumed quantities (Form 7).

2.4.1 Age

The check focused on age is based on assessing the prevalence of heaping, under the assumption that accuracy in age reporting can proxy for numeracy and/or overall data quality. Approximation in age reporting manifests itself in the phenomenon of heaping in self-reported age data, that is, the increased likelihood of respondents or interviewers reporting "round" numbers (typically, multiples of five). We investigated the extent of age heaping in two ways.

Figure 2.1: Age heaping in Maldives, 2016



Source: Authors' own estimation based on HIES 2016 data.

First is a visual inspection. Figure 2.1 shows the frequency distribution of the variable age and we observe that there is no clear tendency to heaping.

A second way of looking at the same phenomenon consists in calculating the Whipple index:

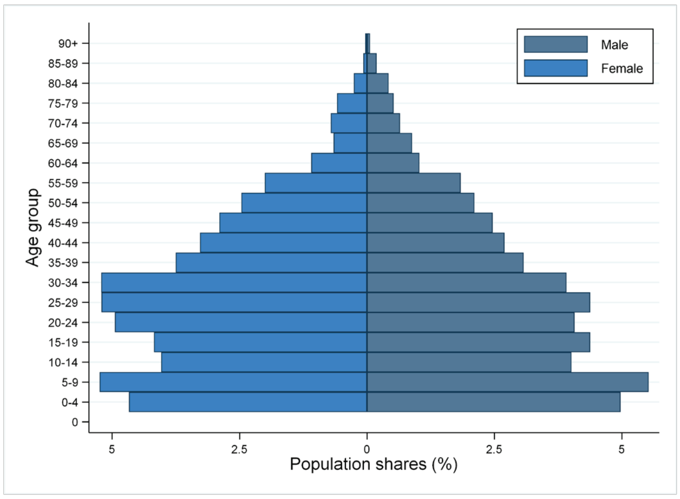
(3) $$W = \frac{(n_{25} + n_{30} + \cdots + n_{65} + n_{70})}{\frac{1}{5}\sum_{i=23}^{72} n_i}$$

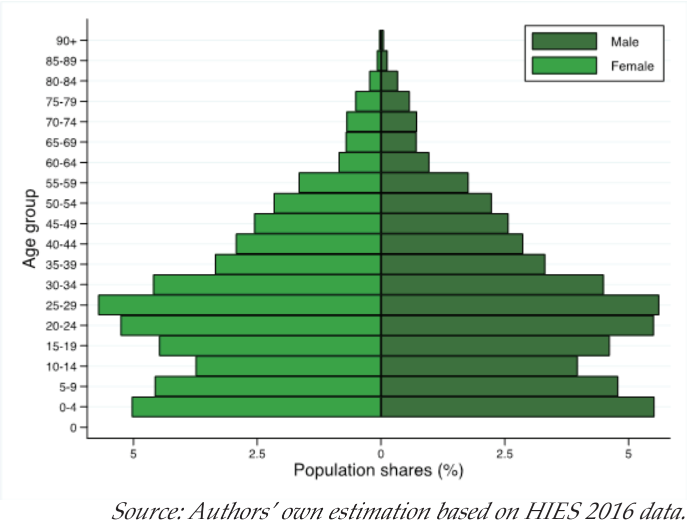
The Whipple index takes on a value of 500 in the presence of perfect heaping on multiples of five, that is under the (hypothetical) situation in which all individuals report ages ending in 0 and 5; a value of 100 represents no preference for "0" or "5" (no heaping at all).[3] The Whipple index on 2016 HIES data equals 104.04, which according to the standard used by the United Nations indicates only a moderate tendency to heaping, classifying the quality of data as "very accurate".[4]

2.4.2 Expansion factors

Regarding expansion factors, Figure 2.2 shows the estimated population pyramid based on the sample data, after non-residents have been excluded, and compares it with the one based on the 2014 population census. This is useful to visually inspect for the presence of flaws in the structure of the population by age and gender.

Figure 2.2: Survey- and census-based population pyramids





Source: Authors' own estimation based on HIES 2016 data.

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3 *The choice of the range 23 to 72 is a popular, albeit arbitrary, one. When computing indexes of heaping, ages during childhood and old age are often excluded because they are affected by errors of reporting other than the preference for specific terminal digits.*

4 *See http://unstats.un.org/unsd/demographic/products/dyb/dybcens.htm.*

2.4.3 Calorie intake

A powerful indicator of the overall quality of the data is the estimated calorie intake, per capita, per day. In this section, we focus on quantities consumed and omit the calories from meals consumed outside the home for the purpose of data validation. The aim is to come up with an estimate of the calorie intake at the household level (kcal/person/day). To calculate the calorie intake, we need to (i) standardize consumed quantities, that is to convert consumed quantities into grams, or kg, or any other standard-metric measurement unit, and (ii) identify calorie coefficients to convert quantity into calories.

Section 3.1 provides details on how to standardize consumed quantities. To convert quantities to calories, we take advantage of the meticulous work undertaken by the NBS, where a set of calorie conversion coefficients is given for each COICOP. The table is too large to report here, but is available upon request.

Table 2.2 shows the distribution of calorie intake by Atoll for different percentiles of the population.

Table 2.2: Distribution of calorie intake (kcal/person/day), net of meals consumed outside home

ATOLLS	p10	p25	p50	p75	p90	mean
MALE	1,069	1,496	2,130	2,842	4,077	2,391
HA	1,247	1,660	2,356	3,292	4,163	2,685
HDH	1,221	1,732	2,229	3,289	4,575	2,779
SH	1,065	1,550	2,375	3,112	4,401	2,619
N	1,369	1,989	2,708	3,439	5,374	2,975
R	955	1,457	2,224	3,512	4,706	2,737
B	1,133	1,598	2,209	3,051	3,859	2,549
Lh	1,206	1,644	2,409	3,311	4,554	2,734
K	784	1,358	2,092	2,961	4,719	2,449
AA	1,219	1,682	2,383	3,326	4,720	2,705
Adh	1,181	1,662	2,191	2,881	4,114	2,465
V	1,623	1,904	2,724	4,129	6,779	3,484
M	1,023	1,585	2,264	3,721	4,939	2,823
F	1,203	1,562	2,242	3,434	4,672	2,616
Dh	706	1,205	1,718	2,435	3,558	2,066
Th	691	1,144	1,936	3,027	4,715	2,372
L	825	1,394	2,177	3,126	4,276	2,506
GA	909	1,439	2,309	3,650	5,609	2,926
GDh	892	1,327	1,942	2,965	4,141	2,325
Gn	856	1,157	1,798	2,741	3,857	2,148
S	909	1,272	1,949	2,809	4,475	2,334
Maldives	1,022	1,476	2,161	3,079	4,353	2,505

Source: Authors' own estimation based on HIES 2016 data.
Note: p10 refers to the 10th percentile, p25 to the 25th percentile, etc.

The overall strategy to construct the welfare indicator, or consumption aggregate (CA), consists in estimating four main building blocks, according to the following formula:

$$CA = \frac{x^F + x^{NFND} + x^{HOUS} + x^{CF}}{CPI \times SPI \times hsize}$$

where:

x^F denotes the (nominal) food consumption aggregate (section 3.1)

x^{NFND} is for non-food non-durable expenditures (section 3.2)

x^{HOUS} denotes housing (section 3.3)

x^{CF} is the consumption flow from durable goods (section 3.4)

CPI is the temporal consumer price index (section 4)

SPI is a survey-based spatial price index (section 4.2)

hsize is the household size

The numerator of the above equation gives the nominal total household expenditure. After dividing it by the household size, we obtain the nominal CA, or nominal PCE (per capita expenditure). The denominator transforms nominal expenditures into real expenditures by adjusting them for inflation and differences in the purchasing power across different Atolls.

The nominal food consumption aggregate is obtained as the total value of consumed food items and food consumed outside the home, such as at restaurants, cafés etc. In the survey instrument, each household reports whether they consumed any given food item in the reference period of the past 7 days (question 3) and if so, how much of it they consumed (question 6). Households thus do not report the monetary value for consumption (as is common in many consumption surveys around the world), instead, they report whether they purchased any given item (question 9), how much of it (question 11), and its value in MVR (question 12). Therefore, the "consumption" part must be supplemented using information from the "purchased" part, to obtain an estimate of the value of consumption, our preferred indicator of food expenditure (Figure 3.1).

Figure 3.1: Survey instrument for food consumption and purchased

Q3. During the past 7 days, did any member of this household consume or purchase any of the following food items I am asking?

Item Code	Item Name	Consumption in the past 7 days						Purchased in the past 7 days				Item Name
		During the past 7 days, did any HH member consume (ITEM)? 1. Yes 2. No Skip to Col. 9	What was the quantity of (ITEM) consumed in the last 7 days? Unit: 1. Gram 2. Kilogram 3. Millilitre 4. Litre 5. Tea Spoon 6. Table Spoon 7. Laahi (Skip to Col. 6) 8. Gandu 9. Other (Specify)	Size: 1. Small 2. Medium 3. Large	QTY	How much of it was own production? IF NONE, WRITE "0" QTY	How much of it was received as gifts or by other means? (Do not include items purchased by the HH) IF NONE, WRITE "0" QTY	During the past 7 days did any members of this household purchase (item)? 1. Yes 2. No Skip to next item	Unit: 1. Gram 2. Kilogram 3. Millilitre 4. Litre 8. Gandu 9. Other (Specify)	What was the TOTAL quantity of (ITEM) purchased during the past 7 days and how much did you spend in total? QTY	AMOUNT (MVR)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
01.1.1	Bread and cereal related items											
01.1.1.1	Rice	1. Yes 2. No Skip to Col. 9						1. Yes 2. No Skip to next item				
0111101	Normal Rice	1 2	1 2 3 4 5 6 7 8 9	1 2 3				1 2	1 2 3 4 8 9			Normal Rice
0111102	Basmathi Rice	1 2	1 2 3 4 5 6 7 8 9	1 2 3				1 2	1 2 3 4 8 9			Basmathi Rice
0111104	White Rice	1 2	1 2 3 4 5 6 7 8 9	1 2 3				1 2	1 2 3 4 8 9			White Rice
0111106	Brown Rice	1 2	1 2 3 4 5 6 7 8 9	1 2 3				1 2	1 2 3 4 8 9			Brown Rice
		1 2	1 2 3 4 5 6 7 8 9	1 2 3				1 2	1 2 3 4 8 9			
		1 2	1 2 3 4 5 6 7 8 9	1 2 3				1 2	1 2 3 4 8 9			
01.1.1.2	Bread and alike	1. Yes 2. No Skip to Col. 9						1. Yes 2. No Skip to next item				
[illegible]	Bread (sliced loaf)	1 2	1 2 3 4 5 6 7 8 9	1 2 3				1 2	1 2 3 4 8 9			Bread (sliced loaf)

Source: HIES 2016 questionnaire, Form 7.

We produced an estimate of the value of consumed items by undertaking three steps: (i) we converted both consumed and purchased quantities into a common, standard measurement unit, namely grams; (ii) we estimated unit values for each food item and household, as the ratio of the expenditure for any given (purchased) item and the corresponding standardized quantity in grams; and (iii) we used these unit values to price all consumed quantities in grams.

The first step concerns the conversion of all reported quantities into standard measurement units. Households report food consumption and purchases using a 9-category variable to specify measurement units (Figure 3.1, question 3, column 4) with the 9th category being an "other" option where households can report any measurement unit. This leads to households using a multiplicity of non-standard measurement units (pieces, cups, bags, slices, sachets, tins, cubes, as well as a large number of hard-to-translate-into-English local measurement units), which adds to the complexity of analyzing food consumption data. Over half of all reported units that households reported were reported using "other" (non-standard measurement units) and 470 and 280 different measurement units were reported by households for consumed and purchased items respectively. Furthermore, for categories 8 (gandu) and 9 (other specify), respondents must specify the size of the unit, choosing among one of three categories: small, medium or large (Figure 3.1, question 3, column 5). Given that most items can only be purchased in a pre-standardized measurement unit and size, the same question on size is not asked for purchased items.

Given the challenge of non-standard measurement units, NBS undertook a cumbersome process of "standardizing" non-standard measurement units. This included to convert standard metric measures (such as half kg, liters, etc.) into kilograms or grams by means of standard equivalences. A second, more challenging, step, included the conversion of non-metric units which are standardized in the Maldives, such as the "laahi" (which can be assumed to be approximately equal to 250 grams), and the "gandu".[5] Non-standard, non-metric units clearly require special treatment. They must be converted into standard units (e.g. grams) to be able to proceed with the detection and treatment of outliers, the estimation of unit values, the calculation of the kilocalorie intake at the household level, etc. as all these activities presume that quantities have been expressed in terms of a common standard unit. Table 3.1 shows the frequency distribution of measurement units of consumed and purchased food items.

5 *See Reynolds (2003).*

Table 3.1: Frequency of non-standard measurement units

	PURCHASES		CONSUMPTION	
UNIT	frequency	%	frequency	%
GRAM	13,570	13.8	20,694	11.5
KILOGRAM	16,739	17.0	14,676	8.1
MILLILITRE	541	0.6	1,413	0.8
LITRE	2,154	2.2	3,077	1.7
TEA SPOON	0	0.0	17,157	9.5
TABLE SPOON	0	0.0	12,580	7.0
LAAHI	0	0.0	7,966	4.4
GANDU	854	0.9	3,988	2.2
OTHER	59,300	60.1	95,708	53.1
.	5,468	5.5	2,988	1.7
TOTAL	98,626	100.0	180,247	100.0

Source: Authors' own estimation based on HIES 2016 data, Form 7-Q3.

The solution for converting non-standard measurement units hinges on a food conversion table, completed by the NBS, with COICOP-specific gram conversion factors for all non-standard measurement units recorded in the HIES 2016 datasets. The table is too large to be reported here, but is available upon request and Table 3.2 shows the breakdown of the "other" category.

Table 3.2: Frequency distribution of reclassified non-standard measurement units (unit = "other" in Table 3.1)

	PURCHASES		CONSUMPTION	
UNIT	frequency	%	frequency	%
GRAM	119	0.2	474	0.5
KILOGRAM	49	0.1	53	0.1
MILLILITRE	0	0.0	37	0.0
LITRE	0	0.0	1	0.0
TABLE SPOON	0	0.0	22	0.0
LAAHI	29	0.1	3	0.0
GANDU	0	0.0	1	0.0
PACKET	24,463	41.3	26,562	27.8
BAG	337	0.6	957	1.0
CUP	1,132	1.9	1,974	2.1
CASE	715	1.2	254	0.3
SINGLE PIECE	55	0.1	3,503	3.7
PIECE	12,028	20.3	34,060	35.6
DABIYAA	69	0.1	67	0.1
CAN	8,113	13.7	9,502	9.9
BOX	1,015	1.7	612	0.6
THASHI	128	0.2	99	0.1
TRAY	73	0.1	60	0.1
KIBA	92	0.2	301	0.3
BOTTLE	5,239	8.8	4,935	5.2
BUNCH	339	0.6	1,352	1.4
HALF	3	0.0	23	0.0
CONE	45	0.1	147	0.2
TUB	131	0.2	249	0.3
PINCH	0	0.0	14	0.0
PILL/CAPSULE	0	0.0	43	0.0
CARTON	28	0.1	75	0.1
PORTION	47	0.1	9	0.0
.	5,050	8.5	10,319	10.8
TOTAL	59,300	100.0	95,708	100.0

Source: Authors' own estimation based on HIES 2016 data, Form 7-Q3.

The NBS conversion factors were validated using two different procedures. First, we estimated the conversion factors using the method first introduced in Amendola, Vargas Hill and Vecchi (2014). In essence, COICOP-specific conversion factors can be estimated calculating the ratio between the average (or median) expenditure of a non-standard measurement unit-reported item and the corresponding expenditure for the same item for kg-denominated items. Estimated coefficients were used as a diagnostic tool for verifying the consistency of the NBS conversion factors (Figure 3.2).

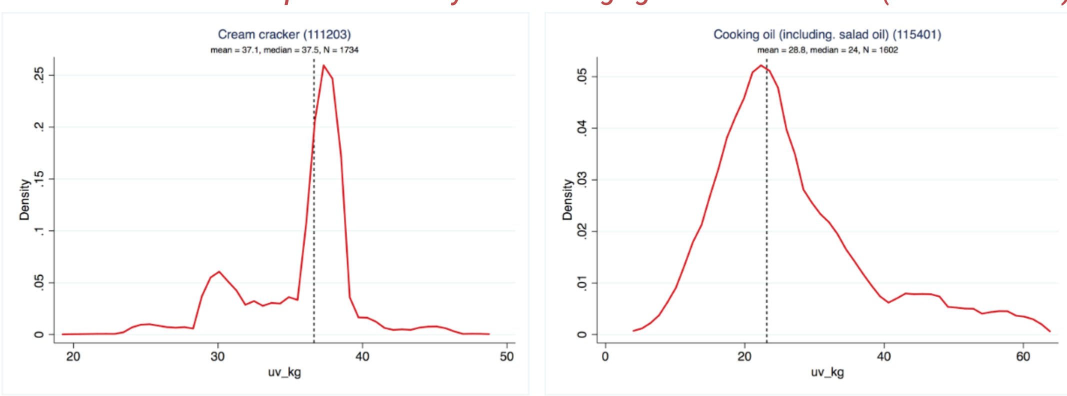
Figure 3.2: Calculated conversion factors (selected items)

	A	B	C	D	E	F	G	H
1	coicop	coicop	finalunit	finalsize	k	conv	countkg	ratio (k/conv)
2	Long grain rice, parboiled - Haru handoo	111101	kilogram	medium	1.0	1.0	1697	1.0
3	Long grain rice, parboiled - Haru handoo	111101	laahi	medium	0.7	0.3	1697	2.8
4	Long grain rice, parboiled - Haru handoo	111101	packet	medium	9.3	1.0	1697	9.3
5	Long grain rice, parboiled - Haru handoo	111101	bag	small	44.1	1.0	1697	44.1
6	Long grain rice, parboiled - Haru handoo	111101	bag	medium	44.1	2.0	1697	22.1
7	Long grain rice, parboiled - Haru handoo	111101	bag	large	44.1	50.0	1697	0.9
8	Wheat flour	111601	kilogram	medium	1.0	1.0	2070	1.0
9	Wheat flour	111601	laahi	medium	1.0	0.2	2070	5.1
10	Wheat flour	111601	packet	small	2.0	1.0	2070	2.0
11	Wheat flour	111601	packet	medium	2.0	3.0	2070	0.7
12	Wheat flour	111601	packet	large	2.0	5.0	2070	0.4
13	Wheat flour	111601	bag	small	40.0	5.0	2070	8.0
14	Wheat flour	111601	bag	medium	40.0	10.0	2070	4.0
15	Wheat flour	111601	bag	large	40.0	50.0	2070	0.8

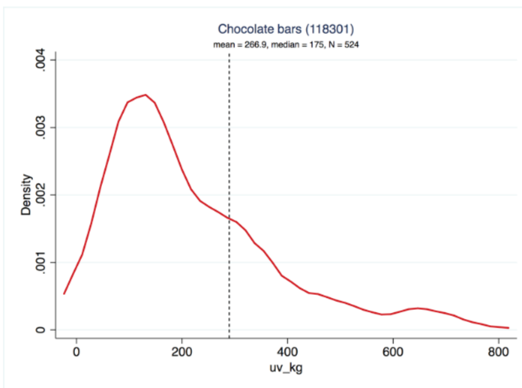
Source: Authors' own estimation based on HIES 2016 data.

A second check was carried out by comparing unit values (calculated after standardizing quantities into grams) with market prices as collected by NBS in Male in May 2017 (Figure 3.3 illustrates). For certain items unit values (red curves in the figures) match very well with market prices (vertical dashed lines)—distributions are unimodal and the mode of the distribution is close enough to the vertical line—while for others we observe problems due to either the presence of multimodal distributions or a substantial gap between mode and vertical bar. These two methods were useful as a diagnostic tool to fine-tune the NBS conversion table.

Figure 3.3: Unit values vs. market prices as a way of validating kg conversion factors (selected items)



Source: Authors' own estimation based on HIES 2016 data, Form 7-Q3.



Second, we estimated unit values for each food item and household, as the ratio between the expenditure for any given item and the corresponding standardized quantity in grams. For some households, we cannot directly estimate unit values as the household does not have information on purchases (and thus amount spent on a food item). These households may still consume certain items, such as items that originated from own-production, were purchased prior to the reference period, were received as gifts, etc. In those cases, we impute the missing unit values for commodity j within household h. We follow a standard hierarchical imputation procedure, that can be summarized as follows:

(4)

$$uv_j^h = \begin{cases} uv_j^h & \text{if } uv_j^h \text{ is not missing} \\ uv_j^p = E(uv_j | PSU\ of\ h) & \text{if } uv_j^h \text{ is missing} \\ uv_j^a = E(uv_j | atoll\ of\ h) & \text{if } uv_j^p \text{ is missing} \\ uv_j^r = E(uv_j | region\ of\ h) & \text{if } uv_j^a \text{ is missing} \\ uv_j^0 = E(uv_j | Maldives) & \text{if } uv_j^r \text{ is missing} \end{cases}$$

where the expression $E(uv_j | \cdot)$ enotes the median of unit values in each subgroup of observations. In practice, we calculate median unit values, instead of means, as this statistic is more robust in the context of skewed distributions.

Third, we used unit values to price all consumed quantities (inclusive of own-production and items received for free, as a gift or by other means) in grams. We obtain the food consumption aggregate as:

(6)

$$x^F = \sum_{j=1}^{J} q_j^{cons} \times uv_j^h + \sum_{j=1}^{J} x_j^m$$

where q_j^cons denotes the consumed quantity of the jth item, uv_j^h is obtained as in equation 5, and x_j^m denotes the reported expenditure for meals prepared outside or consumed at restaurants, cafés etc.

One last issue worth discussing is the presence of universal subsidies on rice, wheat flour, and sugar in the Maldives. In particular:

1. The price of **rice** (COICOP 0111101) was changed from MVR 3.98 (June 8, 2011) to MVR 7.96 (October 1, 2016). It was again changed to MVR 6.76 in May 2017.

2. The price of **wheat flour** (COICOP 0111601) was changed from MVR 2.98 (June

8, 2011) to MVR 5.96 (October 1, 2016) it was again changed to MVR 6.80 in May 2017.

3. The price of **sugar** (COICOP 0118101) was changed from MVR 4.00 (June 8, 2011) to MVR 8.00 (October 1, 2016); it was again changed to MVR 5.26 in May 2017.

The above-mentioned prices are State Trading Organization (STO) wholesale prices and the controlled price of each commodity includes freight and handling charges. Subsidies represent a problem that can bias both inequality and poverty measurement (Hentschel and Lanjouw, 2000). The key principle here is that when we compare welfare across households, we must value quantities consumed at identical prices across households. The combination of spatial and temporal deflation, as described in4 and 4.2 provides a way to adjust for these three items.

Food consumed outside the home is treated differently from the approach described above. Households record the amount paid for food produced outside the home and therefore, the monetary value is added to the food consumption aggregate.

Figure 3.4: Survey instrument for food consumed outside the home

Food produced outside or consumed at a restaurant, café' etc, for all or most members (during the past 7 days)

Q5. In the past 7 days, did all or most of your household members consume meals produced outside or eat at a restaurant?
(include the food brought home and consumed and those consumed at another household, in a cafe' or restaurants, etc).

1. Yes (specify details) 2. No

! DO NOT include food produced outside or consumed by individual members while at work or by most members of the expenditure units.

Item Code	Item	During the past 7 days, did you consume an (ITEM) produced at a restaurant, café, or a takeaway shop or another HH 1. Yes 2. No ☛ **Skip to Next Item**	What was the quantity of (ITEM) consumed in the past 7 days? **specify unit codes accordingly, as given in the table**			Cost of items bought
			Unit Code	Quantity		
				Purchased	Received	Value in MVR
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
	Short eats	1 2				
	Cake alike	1 2				
	Sandwich/buns	1 2				
	Pizza	1 2				
	Burger	1 2				
	Continential (bread,jam,butter)	1 2				
	Roshi meals	1 2				
	Rice meals	1 2				
	Noodles/Pasta meals	1 2				
	Soups	1 2				

Source: HIES 2016 questionnaire, Form 7.

3.2 EXPENDITURES ON NON-FOOD NON-DURABLES

The non-food component of the consumption aggregate includes a set of goods which are widely heterogeneous (e.g., soap, cleaning supplies, newspapers, personal care items, clothing, footwear, kitchen equipment, curtains, bedcovers, etc.). These items are often collected for different reference periods, for example, from consumption in the last 30 days, past 3 months to the last year and expenditures therefore have to be brought to the same reference period (in our case annual). The most difficult challenge is what set of "non-food" items to include in the overall consumption aggregate. In general, "lumpy" and relatively infrequent expenditures associated with events like marriage celebrations, dowries, births, and funerals should ideally be "smoothed" or spread over several years. Deaton and Zaidi (2002) recommend excluding them from the consumption aggregate and we followed this recommendation. We thus excluded expenditures on health and funeral items.

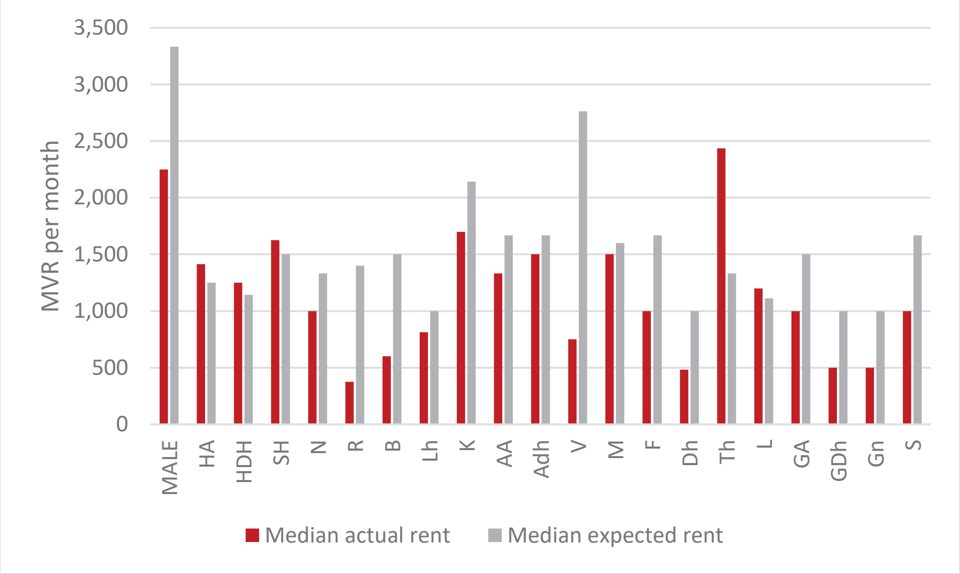
The motivation for excluding that health-related expenditures are considered a "regrettable necessity": an individual who falls ill is likely to spend a substantial amount of money which if added will increase total expenditures and therefore their level of welfare when in fact, the opposite may be the case. Furthermore, it is challenging to acquire complete information on financing of health expenditures as people may have insurance.

3.3 EXPENDITURES ON HOUSING

Housing is defined as the value of the flow of services that a household receives from occupying a dwelling rather than the expenditure of purchasing the dwelling itself. Purchasing a house is a very large and rare expenditure, thus, it should never be included in the welfare aggregate (Deaton and Zaidi, 2002). To measure the flow instead of the stock, payments in rent seem to be a more appropriate choice. However, many households own their dwelling and values on rent are not observed for households that own a dwelling. Furthermore, not all tenants pay the market price for their dwellings, as they may enjoy subsidized arrangements, live for free in a dwelling provided by their employer or by a family member. One way to value the flow of services from dwellings in the welfare aggregate is to estimate the implicit rent a household would pay if he had to rent a dwelling similar in size and quality by means of some imputation method. Another method is based on gathering data on owners' (and non-market tenants) estimates of a fictitious market rental price of a household's owned dwelling. For example, homeowners can be asked to estimate how much they think they would pay if they had to rent their home. In the case of Maldives, we use a combination of the two approaches.

The HIES 2016 survey instrument collects information on paid rent for those households that rent their dwelling (Question 29: "How much is the monthly rent?") and the rental equivalent for households that own their dwelling (Question 28: "How much would you expect to receive each month for this house if you rented it out to someone?") in Form 2, section 1 on living conditions. Figure 3.5 shows that there are substantial data challenges in estimating rental values using HIES data. Part of the problem is due to the fact that there is no reliable rental market outside of Male'—where the 95 percent of households own their dwelling, compared to 36 percent in Male'—which does not allow for households to either report rent or hinders the knowledge about expected rent. This is the case in many countries around the world, where rural areas practically do not have a rental market. In Maldives, however, we find an additional complication, namely the existence of guesthouses on many islands of the Atolls which distort the expected rent values. We thus observe substantial variations in self-reported values of expected rents across Atolls with numerous Atolls showing unreasonably overreported values (Figure 3.5). Furthermore, we imputed missing values by using the median rent (actual or expected depending on whether they rent or own) of the island; in cases where this was not available, we applied the median rent of the Atoll and in case this was not available, we applied the median rent of the region. For households for which we do not have missing information on actual and expected rent as well as whether or not they rent, we apply a hedonic housing regression (see details below). We further cleaned for outliers by restricting the top and bottom 1 percent and using the top and bottom 1 percentile respectively.

Figure 3.5: Rent and self-reported imputed rent per capita, by Atoll



Source: Authors' own estimation based on HIES 2016 data.

Given the data challenges in the Atolls mentioned above, we decided to, use a slightly different approach in Male' and the Atolls. In Male', where data was deemed to be reliable, we use the reported value of actual rent for those households renting their dwelling. For households, that do not pay rent, either because they own the dwelling or because they occupy it for free, we use the self-reported expected rent. In the Atolls, however, we use a **hedonic housing regression model** to predict monthly rents based on dwelling characteristics for households, using actual rent as our independent variable. The results are shown in Table 3.3.

Table 3.3: Rent expenditures, by Atoll

ATOLL	MEAN TOTAL RENT	MEAN ACTUAL RENT	MEAN IMPUTED RENT
MALE	13,690	12,514	15,756
HA	4,999	6,917	4,847
HDH	4,563	3,184	4,574
SH	4,700	6,705	4,608
N	5,316	2,239	5,381
R	4,826	6,968	4,864
B	5,521	1,400	5,612
LH	4,752	2,909	4,856
K	6,054	6,239	5,953
AA	6,792	2,399	6,886
ADH	6,461	2,550	6,512
V	5,998	4,951	6,025
M	5,489	1,678	5,578
F	6,428	1,683	6,562
DH	6,331	2,297	6,447
TH	5,082	3,574	5,100
L	5,509	4,120	5,530
GA	3,607	2,092	3,628
GDH	3,627	3,088	3,688
GN	4,024	1,846	4,059
S	3,976	4,115	3,987

Source: Authors' own estimation based on HIES 2016 data.
Note: Mean rent refers to mean rent by atoll. In the case of atolls, this is either actual rent or imputed rent, depending on whether households rent or own their dwelling. For Male, this refers to either actual rent or self-reported expected rent. For Male we use expected rent in the column for imputed data

3.4 EXPENDITURES ON DURABLE GOODS

Consumer durables play a key role in determining households' well-being and the consumption of durable goods or assets such as automobiles, fridges, televisions, cellular phones, etc., should be included as part of the welfare measure. The main measurement challenge concerning the inclusion of durables is that their life-span typically exceeds the time-period for which the consumption aggregate is constructed and that they "deliver useful services to a consumer through repeated use over an extended period of time" Diewert (2009, p. 447). Consequently, the purchase market price of a durable good is not an adequate pricing concept to estimate the value of the benefits from using the durable good. As a matter of fact, the purchase market price corresponds to the value of the durable good for its entire economic life, while only a fraction of the market value reflects the value of the benefits delivered by the durable good during the survey year. Therefore, it is recommended to only include the flow of the service that these goods yield rather than their total expenditure. To calculate the consumption flow from durable goods measure of depreciation and estimates on the current value have to be taken into consideration. To obtain these data, possibly the easiest way is to ask respondents when durables were purchased and how much they cost at the time of purchase. In this section, we illustrate the procedure used to estimate the consumption flow from durable goods for Maldives for 16 durable good included in the HIES 2016.

There are many theoretical approaches that can be adopted to estimate the consumption flow from durables. One of the most popular one, for theoretical and empirical reasons, is the **user cost method** (See Amendola and Vecchi (2014) for a detailed discussion).

The user cost method can be summarized as follows. Consider a household that owns a durable good whose market value at the beginning of the survey year t is p_t . The household has two options: One, the household can sell the durable good and invest the revenue on the financial market. In this case, at the end of the year, the household receiv es $p_t(1+i_t)$, where i_t is the market nominal interest rate. Two, the household can use the durable good and sell it at the end of the year. In this case, the household obta ins $p_t(1+\pi_t)(1-\delta)$ where π_t is the year t inflation rate and δ is the annual technological deterioration rate, assumed to be constant over time. The difference between the value of the two options at the end of the year is the cost that the household is willing to pay for using the durable good for one year, and measures the consumption flow from the durable good, x^{CF} :

(7) $$x^{CF} = p_t(1+i_t) - p_t(1+\pi_t)(1-\delta)$$

By assuming that $\delta \times \pi_t \cong 0$, , equation (7) simplifies to:

(8) $$x^{CF} = p_t(r_t + \delta)$$

where $r_t = i_t - \pi_t$ is the real market interest rate in period t.

The estimation of x^{CF} , as defined in equation (8) requires, for each durable good, knowledge of the following pieces of information:

- The current market value p_t of each consumer durable. We estimate this value using question 11 in module 2.
- The real interest rate r_t . We estimate it as the difference between the nominal interest rate i_t (we use Central Bank interest rates referred to low-risk/safe assets, such as, mid-long termed government bonds) and π_t , the temporal CPI.
- The deterioration rate δ. This parameter must be estimated based on the survey information. For each durable items recorded in this section we know: (i) how many durable goods the household have access to; (ii) how many durable goods the household owns; (iii) how many durable goods the household purchased or received during the last 12 months; (iv) the purchasing year [t-k] of the most recent durable; (v) the paid price at the purchasing year $[p_{t-k}]$ for the most recent durable; and (vi) a subjective estimate of the current market value of the most recent durable $[p_{t-k}^{t}]$. Information (i) to (vi) allows us to estimate deterioration rate δ.

The question becomes how to estimate the deterioration rate δ. We observe that the current market value of a durable purchased in year t-k can be expressed as a function of the price paid in year t-k, of the inflation rate between years t-k and t and of the deterioration rate δ:

(9)

$$p_{t-k}^{t} = p_{t-k} \prod_{i=t-k}^{t} (1+\pi_i)\,(1-\delta)^k$$

We can simplify equation (9) by calculating an average annual inflation rate π as follows:

(10)

$$\prod_{i=t-k}^{t} (1+\pi_i) = (1+\pi)^k$$

Substituting into equation (9) and solving for δ, we obtain:

(11)

$$\delta = 1 - \left(\frac{p_{t-k}^{t}}{p_{t-k}(1+\pi)^k}\right)^{\frac{1}{k}}$$

We estimate equation (11) for each household, separately for each item. Let h denotes household, and j the item. Note that (i) p_{t-k} is question 10 in Module 2; (ii) p_{t-k}^{t} was defined above (question 11, Module 2); (iii) the parameter π is from equation (10); (iv) the parameter "k" is question 8 in module 2.

Operationally, for each household h that reports non-zero consumption of the durable good j and provides all the information (i) to (vi), we can calculate the deterioration rates δ_h (j) based on equation (3), and then take the median value:

(12) $\hat{\delta}(j) = Median[\delta_h(j)]$

For households that own a durable j of vintage k and reported the current value of the durable $p_{h,t-k}^{t}$, the consumption flow from the durable j can be then estimated by applying equation (2):

(13) $\hat{x}_h^{CF}(j) = p_{h,t-k}^{t}\left(r_t + \hat{\delta}(j)\right)$

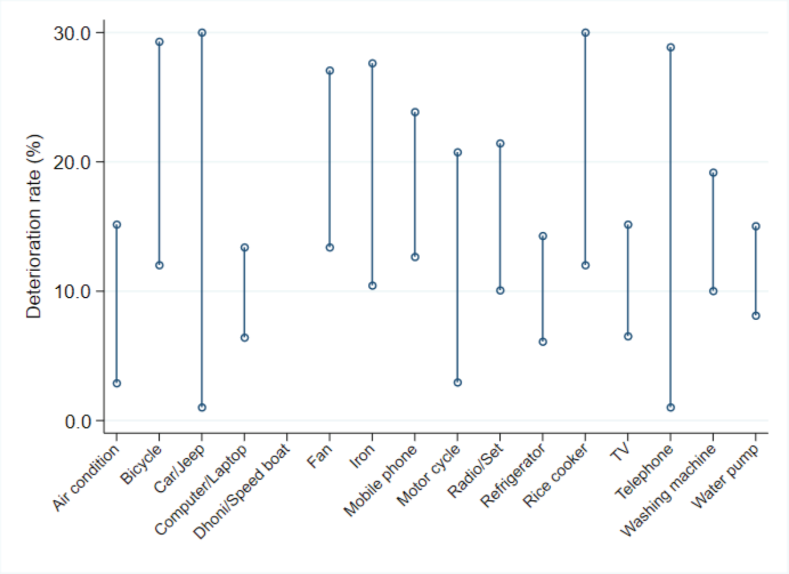
Where r_t is an appropriate real interest rate that capture the average opportunity cost of not investing in the financial markets. Table 3.4 shows the estimated deterioration rates in equation (11) and Figure 3.6 shows the variation of the estimated deterioration rates by Atoll.

Table 3.4: Estimated annual deterioration rates

CONSUMER DURABLE	MEAN	MEDIAN	NO. OBS.
AIR CONDITIONER	0.1734	0.1188	1,701
BICYCLE	0.2642	0.2083	1,905
CAR/JEEP	0.1437	0.0742	142
COMPUTER/LAPTOP	0.1470	0.1148	2,349
FAN	0.2699	0.2083	3,720
IRON	0.2648	0.2240	3,934
MOBILE PHONE	0.2474	0.1976	4,308
MOTOR CYCLE	0.1194	0.0787	1,708
RADIO/SET	0.2195	0.1731	2,028
REFRIGERATOR	0.1590	0.1190	3,502
RICE COOKER	0.2867	0.2387	3,162
TV	0.1634	0.1188	3,553
TELEPHONE	0.2184	0.1541	101
WASHING MACHINE	0.2164	0.1678	3,923
WATER PUMP	0.1676	0.1256	3,117

Source: Authors' own estimation based on HIES 2016 data.

Figure 3.6: Estimated deterioration rates for selected durable goods



Source: Authors' own estimation based on HIES 2016 data.
Note: Each bar represents the range of deterioration rates by Atoll.

Finally, we impute the CF to deal with two circumstances, namely households that report access but not ownership, and records with missing values, including households that report more than one item per type. For all these households, we impute the consumption flow by using the median consumption flow:

(14) $$\hat{x}_h^{CF\prime}(j) = Median\left[p_{h,t-k}^{t}\left(r_t + \hat{\delta}(j)\right)\right]$$

The monthly consumption flow from the durable goods owned or purchased by a household h is then given by $\hat{x}_h^{CF}(j)$ divided by 12.

Table 3.5: Estimated consumption flow for durable goods (MVR/hh/year)

CONSUMER DURABLE	ATOLLS	MALE	TOTAL
AIR CONDITIONER	1,809	2,062	1,941
BICYCLE	494	536	498
CAR/JEEP	15,678	23,258	19,791
COMPUTER/LAPTOP	1,284	2,124	1,718
FAN	458	415	445
IRON	68	87	76
MOBILE PHONE	2,342	5,485	3,697
MOTOR CYCLE	5,527	7,447	6,603
RADIO/SET	109	166	121
REFRIGERATOR	583	778	665
RICE COOKER	136	142	138
TV	966	1,295	1,105
TELEPHONE	80	133	113
WASHING MACHINE	587	752	656
WATER PUMP	283	296	285

Source: Authors' own estimation based on HIES 2016 data.

After compiling each of the four components of the CA, we simply add food, non-food non-durable, consumption flow of durables and rent to get the total nominal consumption aggregate. Table 3.6 shows the nominal consumption aggregate for Male' and the Atolls.

Table 3.6: Components of mean per capita nominal expenditure, by decile (MVR/year)

DECILES	FOOD	NON-FOOD NON-DURABLE	CONSUMPTION FLOW OF DURABLES	RENT	TOTAL
			National		
1	6,823	8,828	837	6,893	23,381
2	10,341	12,024	1,172	9,258	32,794
3	13,218	14,632	1,309	10,483	39,642
4	15,851	17,135	1,466	11,621	46,069
5	17,043	19,232	1,831	14,720	52,826
6	18,983	22,519	2,177	16,298	59,977
7	21,987	25,031	2,525	19,045	68,589
8	22,677	30,656	2,873	23,893	80,099
9	28,337	35,052	3,496	32,196	99,081
10	74,134	54,960	4,974	51,627	185,694
			Atolls		
2	10,711	12,168	1,121	8,757	32,757
3	13,937	14,819	1,386	9,599	39,741
4	16,521	17,328	1,507	10,772	46,124
5	19,135	19,860	1,864	11,981	52,840
6	22,699	22,677	2,045	12,293	59,714
7	26,212	26,358	2,145	13,541	68,256
8	29,079	32,441	2,435	15,998	79,953
9	39,050	38,501	2,826	17,943	98,320
10	61,047	61,304	4,102	27,691	154,144
2	10,711	12,168	1,121	8,757	32,757
			Male'		
1	7,219	10,633	2,557	5,287	25,695
2	6,660	10,594	1,677	14,236	33,166
3	10,591	13,950	1,029	13,708	39,279
4	13,008	16,314	1,291	15,221	45,835
5	14,162	18,366	1,786	18,492	52,807
6	14,929	22,347	2,322	20,666	60,263
7	18,517	23,941	2,838	23,566	68,863
8	19,698	29,825	3,077	27,566	80,167
9	24,123	33,696	3,759	37,803	99,381
10	76,845	53,645	5,154	56,586	192,230

Source: Authors' own estimation based on HIES 2016 data.

4. ADJUSTMENTS TO THE CONSUMPTION AGGREGATE

Once we estimated all the components of the nominal consumption aggregate aggregated at the household level, we undertook three adjustments to the nominal CA to obtain the real living standard at the individual level. The first and second adjustments refer to the adjustment of prices to account for differences in the cost of living across time and space and the third refers to the adjustments for differences in household composition (i.e. difference in the number of household members across households.

The first adjustment which has to be made to the consumption aggregate is to account for differences in the cost of living across time. Prices usually vary across different time periods over the course of data collection of the survey due to inflation. Adjustments are necessary to avoid misleading comparisons between households' nominal consumption expenditures which are due to data collection during different time periods. To adjust for inflation, we used the official monthly food and non-food CPI for the survey reference period to adjust for differences of data collection in different survey months (Table 4.1).

Table 4.1: Time periods of data collection across Atolls.

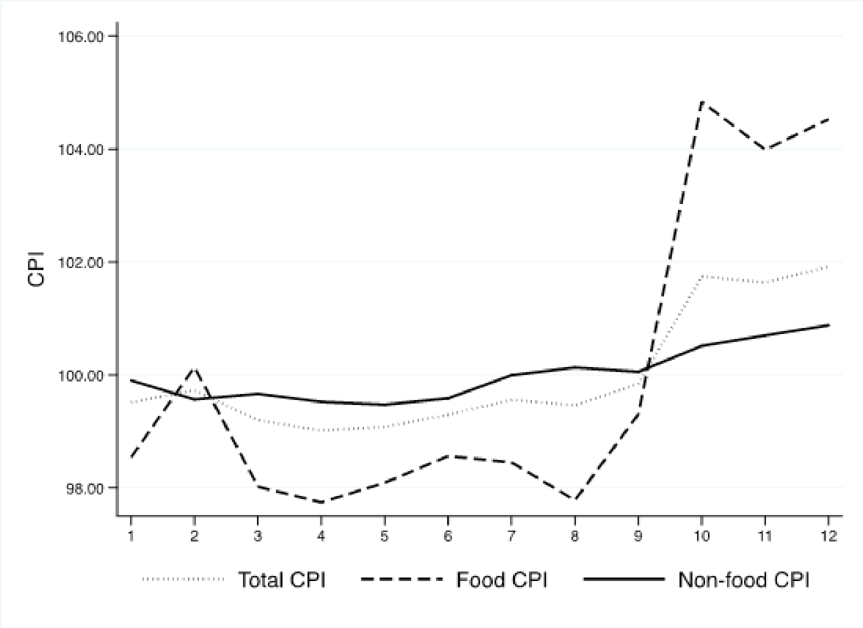
Survey Round	Atoll code	Atoll	Survey Month
1	26	Lh	Apr-16
1	32	F	Apr-16
1	20	HA	Apr-16
2	35	L	May-16
2	38	Gn	May-16
2	29	Adh	Apr-16
3	24	R	May-16
3	37	Gdh	May-16
3	31	M	May-16
4	21	Hdh	Aug-16
4	34	Th	Aug-16
5	23	N	Aug-16
5	36	Ga	Aug-16
5	28	Aa	Aug-16
6	25	B	Sep-16
6	33	Dh	Sep-16
6	30	V	Sep-16
7	22	Sh	Oct-16
7	39	S	Oct-16
7	27	K	Oct-16

Source: HIES 2016 data.

Based on NBS data, we constructed monthly price indices for both food and non-food items and deflated expenditures reported by households not only according to the month of the interview but also according to the recall period of the respective module.

Figure 4.1 displays the monthly CPI during the survey period, the substantial increase in prices, particularly for food, is caused by changes in subsidies for some of the staple food items in the Maldives, namely rice, wheat flour, and sugar.

Figure 4.1: Monthly CPI during the survey period, by category



Source: Authors' own estimation based on HIES 2016 data.

The second adjustment, we undertook was to adjust the CA to account for differences in the cost of living across space. Prices usually vary across different regions in a country and these differences in prices may mislead comparisons between households' nominal consumption expenditures (Gibson, 2007). Monetary welfare indicators must therefore be adjusted for differences in purchasing power due to differences in price levels across the Atolls. To address the spatial variation in prices, the literature suggests several indexes such as Paasche, Laspeyres, or two superlative indices, Fisher and Törnqvist. These price indices have advantages and disadvantages nor do they satisfy the transitivity property. One practical challenge with all price indices is that they require a full set of prices for all items in the consumption basket.

In this section, we describe the overall strategy to deal with spatial price adjustments in the Maldives, based on HIES 2016 data. In essence, we suggest estimating a Paasche index at the household level. This is in line with the recommendations in Deaton and Zaidi (2002).

The Paasche index for the hth household is defined as follows:

(15)
$$P_h = \frac{\sum_j p_j^h Q_j^h}{\sum_j p_j^0 Q_j^h}$$

where p_j^0 is the price of commodity j for the reference group 0. We plan to take the entire population as the reference group, so that p_j^0 is calculated as the average national price of commodity j.

The interpretation of the index P_h in equation (15) is the ratio between the cost of a bundle of goods and services purchased by the hth household and the cost of the same bundle for the "average household", indexed by 0. Equation (15) can be re-written as follows:

(16)
$$P_h = \left[\sum_j w_j^h \left(\frac{p_j^h}{p_j^0}\right)^{-1}\right]^{-1}$$

where w_j^h is the budget share of household h for commodity j, and p_j^h/p_j^0 is the relative price of the jth item.

We estimate the price relativities $\left(p_j^h/p_j^0\right)$ using the information on quantities and values of items purchased by households, as reported in various parts of the questionnaire. The HIES 2016 allows for the estimation of both food and (a selection of) non-food items. The former can be retrieved from Form 7 (Consumption – only variables referring to purchased food items) and the latter from Form 3 (Expenditure Unit). In practice, we focus on the estimation of a Paasche index for food items. The "conventional" argument applies that (i) a food Paasche index does a better job in capturing the consumption pattern of the poor (characterized by high food budget shares), and therefore in deflating their nominal CA, and (ii) non-food expenditures suffer from high heterogeneity which might affect the non-food component for the Paasche index.

Unit values can be calculated for each item as follows:

(17) $$uv_j^h = \frac{x_j^h}{Q_j^h}$$

where x_j^h is the expenditure of household h on commodity j, and Q_j^h is the purchased quantity (per gram, in case of food items). Prior to estimating unit values, we detect outliers in the distribution of unit values at the product level using the procedure described in Section 2.3. Based on "cleaned" unit values, the ratio of price relativities $\left(p_j^h/p_j^0\right)$ in equation (17) can be estimated as follows:

$$\left(\frac{p_j^h}{p_j^0}\right) = \frac{uv_j^h}{uv_j^0}$$

where uv_j^0 is the national average unit value of commodity j.

Note that the jth unit value uv_j^h can be missing even if household h consumes a positive amount of commodity j: this is the case for all consumption items that have not been purchased on the market, either because they originate from own-production, or decumulation of stocks, gifts received, etc. In these cases, it is essential to impute the missing unit values. We follow a standard hierarchical imputation procedure, that can be summarized as follows:

(18)

$$uv_j^h = \begin{cases} uv_j^h & \text{if } uv_j^h \text{ is not missing} \\ uv_j^a = E(uv_j | atoll\ of\ h) & \text{if } uv_j^h \text{ is missing} \\ uv_j^r = E(uv_j | region\ of\ h) & \text{if } uv_j^a \text{ is missing} \\ uv_j^0 = E(uv_j | Maldives) & \text{if } uv_j^r \text{ is missing} \end{cases}$$

Where the expression $E(uv_j | \cdot)$ denotes the mean of unit values in each subgroup of observations. In practice, we calculate median unit values, instead of means, as this statistic is more robust in the context of skewed dist ributions.

Regarding the budget shares w_j^h needed to estimate a food spatial price index, they can be calculated as follows:

(18)

$$_F w_j^h = \frac{\widehat{FHE}_h^j}{\sum_j \widehat{FHE}_h^j}$$

where subscript "F" denotes food, $\widehat{FHE}_h^j$ denotes the (estimated) consumption of food item j by household h, and $\sum_j \widehat{FHE}_h^j$ denotes the (estimated) total food consumption by household h[6] .

We have now all the elements to estimate a food Paasche spatial price index at the household level:

(19)

$$P_h^F = \left[\sum_j {}_F w_j^h \left(\frac{uv_j^h}{uv_j^0} \right)^{-1} \right]^{-1}$$

where j indicates food items only. We will use the index in equation (11) to deflate the nominal CA, thereby obtaining the real CA.

To get a summary of the estimated price index, and assess the plausibility of implied cost of living differences, we aggregate the household-level indices P_h^F by Atoll (and/or regions) by averaging over all the households that belong to a given Atoll A:

(20)

$$P_A^F = E[P_h^F | h \in A]$$

Irrespective of the level of aggregation, we normalize all price indices to give a unitary

6 *Food consumption is estimated because only consumed quantities, not monetary amounts, are available in Form 7, whereas both quantities and expenditures are available for purchases. Consumption expenditure is estimated by pricing consumed quantities using unit values from purchased items.*

average value:

(20) $$P_h^F(normalized) = P_h^F / E[P_h^F]$$

Table 4.2 shows the normalized food Paasche indices by Atoll.

Table 4.2: Food Spatial Paasche Price Index, by Atoll

Atoll	Paasche	Atoll	Paasche
MALE	1.06	V	1.02
HA	0.99	M	0.97
HDH	0.97	F	1.02
SH	0.93	Dh	1.02
N	0.87	Th	1.01
R	1.02	L	0.88
B	0.98	GA	0.94
Lh	1.00	GDh	1.04
K	0.94	Gn	1.11
AA	1.07	S	1.07
Adh	1.00	Maldives	1

Source: Authors' own estimation based on HIES 2016 data.
Note: The Paasche index in was calculated at the PSU level, using the democratic method (Prais, 1954).

Ultimately, practitioners are interested in capturing the welfare measure at the individual rather than at the household level by adjusting total expenditure by household composition. The resulting welfare measure can then be assigned to each household member as an individual rather than the household as a unit. We adjust the welfare aggregate by household composition using household size (i.e. in per-capita terms), which assumes that all individuals in the household have the same needs and that consumption is shared equally among household members.

Furthermore, 250 households had missing food consumption, about 5 percent of the sample size. Given that these households will be used in other modules of the HIES 2016 and that these households miss food consumption at random[7] , we decided to impute food consumption based on a simple regression-based imputation. For 18 households, regressors were not available and these were subsequently dropped from the sample.

7 We were not able to detect any systematic distribution of missing values across the different atolls or across income (proxied by non-food expenditures)

The nominal CA (section 4) is deflated using temporal and spatial price indices (sections 4.1 and 4.2). Table 4.3 displays the breakdown by the four main categories.

Table 4.3: Components of mean per capita real expenditure, by decile (MVR/year)

DECILES	FOOD	NON-FOOD NON-DURABLE	CONSUMPTION FLOW OF DURABLES	RENT	TOTAL
			National		
1	6,593	8,265	889	7,041	22,787
2	10,357	12,643	1,119	9,008	33,128
3	13,592	14,521	1,302	10,780	40,195
4	16,125	17,017	1,610	12,105	46,857
5	17,612	19,557	1,724	14,373	53,263
6	19,578	21,975	2,085	17,155	60,793
7	21,049	26,268	2,483	19,202	69,002
8	24,591	29,878	2,923	23,408	80,800
9	27,216	36,221	3,443	32,260	99,140
10	63,103	53,770	4,779	48,554	170,206
			Atolls		
1	6,671	8,390	844	6,826	22,731
2	10,627	12,663	1,124	8,555	32,968
3	14,357	14,488	1,312	9,816	39,973
4	17,048	17,242	1,622	10,880	46,792
5	19,610	19,837	1,734	12,077	53,252
6	22,514	23,014	1,929	12,982	60,440
7	26,883	25,944	2,242	13,922	68,991
8	31,034	31,860	2,464	15,622	80,980
9	36,901	39,838	2,593	19,256	98,588
10	56,600	62,055	4,313	28,297	151,265
			MALE’		
1	5,774	6,938	1,358	9,316	23,386
2	7,458	12,437	1,064	13,887	34,847
3	11,173	14,628	1,270	13,825	40,897
4	12,834	16,214	1,566	16,475	47,089
5	14,869	19,173	1,711	17,525	53,279
6	16,289	20,811	2,260	21,829	61,189
7	16,800	26,503	2,659	23,047	69,009
8	20,822	28,719	3,191	27,962	80,694
9	22,818	34,579	3,828	38,165	99,391
10	65,070	51,264	4,920	54,681	175,936

Source: Authors’ own estimation based on HIES 2016 data.

5. DATA CHALLENGES

Data challenges are inevitable in the use of survey data. In Maldives, there have been substantial challenges in the use of non-standard measurement units for food consumption by survey respondents which affected over half of all observations. There were nine categories to specify measurement units, one of which was "other" and about 55 percent of all records are reported using non-standard measurement units in the "other" category. NBS has therefore undertaken significant effort to clean, consolidate, and "standardize" these units and created a conversion table which converts non-standard measurement units into grams. However, challenges remain in consumed quantities.

As the poverty measurement process is complex and highly sensitive to data quality, the team was not able to solve all issues on non-standard measurement units and HIES 2016 food quantities remain challenging in correctly ranking individuals according to their welfare using food expenditures. This is most evident in the fact that expenditure deciles based on total expenditure are different from expenditure deciles based on food expenditure but also in a lack of Engel's law. Engel's law states that as income increases, the proportion of income spent on food falls, even if absolute expenditure on food increases. In the case of Maldives, however, we observe increasing budget shares for richer deciles. Table 5.1 shows that the poorest decile spends about 30 percent of all expenditures on food. Engel's law would tell us that food budget shares monotonically decrease with increased income, however, in Maldives, the richest decile has the highest expenditures on food, a budget share of about 37 percent.

Table 5.1: Mean per capita real expenditure and budget share, by decile (MVR/year)

DECILES	FOOD	NON-FOOD NON-DURABLE	CONSUMPTION FLOW OF DURABLES	RENT	TOTAL
			Means		
1	6,593	8,265	889	7,041	22,787
2	10,357	12,643	1,119	9,008	33,128
3	13,592	14,521	1,302	10,780	40,195
4	16,125	17,017	1,610	12,105	46,857
5	17,612	19,557	1,724	14,373	53,263
6	19,578	21,975	2,085	17,155	60,793
7	21,049	26,268	2,483	19,202	69,002
8	24,591	29,878	2,923	23,408	80,800
9	27,216	36,221	3,443	32,260	99,140
10	63,103	53,770	4,779	48,554	170,206
			Budget shares		
1	28.9	36.3	3.9	30.9	100.0
2	31.3	38.2	3.4	27.2	100.0
3	33.8	36.1	3.2	26.8	100.0
4	34.4	36.3	3.4	25.8	100.0
5	33.1	36.7	3.2	27.0	100.0
6	32.2	36.1	3.4	28.2	100.0
7	30.5	38.1	3.6	27.8	100.0
8	30.4	37.0	3.6	29.0	100.0
9	27.5	36.5	3.5	32.5	100.0
10	37.1	31.6	2.8	28.5	100.0

Source: Authors' own estimation based on HIES 2016 data.

Going forward, NBS will focus on better understanding the biggest challenges during data collection that resulted in the large use of non-standard measurement units for food items (i.e. questionnaire design, enumerator training, etc.) and the team will test different ways of collecting food quantities (i.e. show respondents pictures of standard measurement units) as well as understand potential differences in the use of different measurement units across islands to ensure that these challenges will not arise during the next HIES.

Another data challenge is the lack of a rental market in atolls and the resulting small sample size for actual rents in the Atolls. Typically, for renters, the reported value of actual rent is added to the consumption aggregate. For owners, self-reported values of expected rent are applied. There are, however, substantial data challenges in estimating rental values using HIES 2016 data: (i) there is no reliable rental market outside of Male' (few households report actual rent outside of Male'); (ii) there are substantial variations in self-reported values of expected rents across atolls with numerous atolls showing unreasonable values. The team agreed to use actual or expected monthly rent for households in Male' where data was deemed to be reliable and to use a hedonic housing model to predict monthly rents based on dwelling characteristics for households outside of Male'. The team defined context-specific regressors and finalized the specification of the hedonic model used to predict imputed rents with the caveat that the hedonic housing model in atolls is based on a small sample size for which the necessary information is available. Moving forward, the team will, however, better understand how the questionnaire design could be changed to improve on collecting information on rents outside of Male'.

Regarding the adjustment for prices, temporal deflation seems unproblematic. In this report, spatial deflation was limited to food items, which might not be sufficient to adjust for differences in the cost of living across the national territory, especially between Male' and the Atolls.

Given the data challenges, the team decided to maintain the methodology of past years of setting a relative poverty line. The relative poverty line is defined in respect to the median expenditure of the entire population. This means that relative poverty is redefined every time new data becomes available as the median income changes. As the measure to which poverty is compared to (e.g., mean on median income) is revised upwards, so is the poverty line. For example, if everyone's consumption doubles, it is hard to argue that poverty levels remain constant as the relative approach would indicate (Ravallion, 2016). Setting relative poverty lines is therefore more akin to a way to measure inequality in a society rather than poverty itself which defines a minimum level of needs that are physically and socially essential[8] .

In Maldives, the poverty line is set relative to the median income of all Maldivians[9] . Someone who earns less than 50 percent of the median income is considered to live in poverty because he or she is not able to consume goods and services that the rest of society can consume and is therefore excluded from social life. This line was defined as part of the first ever study on poverty, conducted in 1998. The "Vulnerability and Poverty Assessment in Maldives 1998 (VPA 1998)" set the first relative poverty line for the country. The question as to where to set the relative poverty line was considered complex even at that time. Since relative poverty line was commonly by other countries and a common relative poverty line was set at half the median per capita income, a similar approach was applied in the Maldives to determine the poverty line.

A practical approach was used to determine the poverty line based on the theory of pov-

8 *Even though relative deprivation matters, an absolute poverty line is the preferred choice for poverty measurement since it is fixed in terms of the level of well-being. In other words, the poverty line is set in reference to a bundle of consumption that has a fixed purchasing power chosen to cover basic needs. According to Ravallion (2016), the poverty line should remain fixed (in real terms) over time and space (such as regions) to enable policy makers to evaluate the impact of policies and programs on poverty reduction. An absolute poverty line also allows us to overcome the undesirable effect of the relative poverty line which can show constant poverty even when the standard of living of the poor has risen. For all these reasons, we recommend measuring poverty based on an absolute poverty line. The team will move to an absolute measure of poverty during the next survey round once data challenge on food quantities can be overcome.*

9 *In past years, the relative poverty line was set by using the median and half the median of Atoll expenditures as the poverty threshold. To account for the fact that poor Maldivians can also be found in Male', the team decided to use total expenditures rather than Atoll expenditures to set the relative poverty line.*

erty dominance. Instead of trying to establish one poverty line, it was considered fruitful to analyze whether the results of various poverty lines were robust in the sense that the identification of the poor was stable irrespective of the selection of the poverty line. In this framework, a very low poverty line, a relatively high poverty line, and a poverty line drawn somewhere in-between was considered. In this regard, the following different poverty lines was used in VPA 1998:

1. A relatively high poverty line – the atoll median of MVR 15 per person per day was used as a kind of maximum poverty line.
2. A low poverty line – Half the atoll median, that is MVR 7.5 per person per day, or about US$ 0.65 per person per day, was used as the low poverty line.
3. An in-between poverty line- MVR 10 per person per day was set as in-between poverty line. (MVR 7.5- MVR 15)

The first National Level Household Income and Expenditure Survey conducted in 2002/03 (HIES 2002/03) presented the second analysis on poverty for the country. Similar to the VPA 1998, the same three poverty lines were used—at MVR 7.5, MVR 10 and MVR 15 per person per day. For comparison purpose, these lines were maintained in the HIES 2002-03, without adjustments for inflation as inflation during this period was negligible. In addition, the dollar-a-day MDG poverty line was introduced in 2002-03. However, result of poverty using MDG dollar a day showed poverty was negligible in Maldives.

To ensure the policy relevance of the poverty line, poverty line should be chosen according to social norms (with the collective understanding of what represents a minimum standard of living) and that the results obtained with the specific value of the relative poverty line do not depend on the choice of its value. In this regard, since the poverty line was initially set at median and half the median of Atoll expenditures, NBS decided to follow the same methodology in 2009-10. To allow for comparability and consistency across time, the poverty lines for 2002-03 were also revised and drawn at the median and half the median of atoll expenditures of 2002-03. Table 6.1 displays the values of the relative poverty lines for VPA 1998, HIES 2002-03, and HIES 2009-10.

Table 6.1: Poverty lines in Maldives across different survey years (MVR/per person/per day)

POVERTY LINE	IN VPA 1998	IN HIES 2002-03	IN HIES 2009-10
A RELATIVELY HIGH POVERTY LINE – THE ATOLL MEDIAN PER PERSON PER DAY	MVR 15	MVR 32	MVR 44
A LOW POVERTY LINE – HALF THE ATOLL MEDIAN	MVR 7.5	MVR 16	MVR 22
IN-BETWEEN POVERTY LINE	MVR 10		

Source: National Bureau of Statistics.

Note: VPA 1998 poverty lines were also used when initially publishing results for the HIES 2002-03. The HIES 2002-03 results shown in the table above, are the poverty line that were revised and published as part of the HIES 2009-10 in 2009-10 prices.

Based on the real CA constructed in section 5 and consistent with the methodology used in setting the national poverty line using HIES 2009-10, we defined two relative poverty lines—at half the median of total expenditures and at the median of total expenditures (Table 6.2). This line is complemented with an international poverty line, namely the "upper middle-income poverty line" which was recently released by the World Bank (Joliffe and Prydz, 2016). As differences in the cost of living across the world evolve, the global poverty line has to be periodically updated to reflect these changes and in 2017, the World Bank adopted an international poverty lines by income class: (i) the low income International Poverty Line, et at $ 1.90/per day; (ii) the lower middle-income International Poverty Line, set at $3.20/day; and (iii) the upper middle-income International Poverty Line, set at $5.50/day. The introduction of the middle-income lines serves two purposes. First, it accounts, in a simple manner, for the fact that achieving the same set of capabilities may require a distinct set of goods and services in different countries—and, specifically, a costlier set in richer countries. Second, it allows for cross-country comparisons and benchmarking both within and across developing regions, something that a growing number of countries is interested in and was not possible before, using regional lines.

Table 6.2: National relative poverty lines in Maldives (MVR/per person/per day)

POVERTY LINE	HIES 2016
HALF THE MEDIAN OF TOTAL EXPENDITURES	MVR 74
MEDIAN OF TOTAL EXPENDITURES	MVR 148
UPPER MIDDLE INCOME INTERNATIONAL POVERTY LINE	MVR 70

Source: Authors' own estimation based on HIES 2016 data.
Note: Upper Middle Income International Poverty Line was converted from 2011 US Dollars to Maldivian Rufiyaa by using Purchasing Power Parities (PPP) conversion factor and CPI.

Table 6.3 displays the resulting poverty rates applying the two national poverty lines and the upper-middle income international poverty line.

Table 6.3: Poverty rates using national relative poverty lines in Maldives (% of the population)

POVERTY LINE	POVERTY RATE	POVERTY GAP	SQUARED POVERTY GAP
HALF THE MEDIAN OF TOTAL EXPENDITURES	8.2%	1.6%	0.5%
MEDIAN OF TOTAL EXPENDITURES	46.5%	13.9%	5.8%
UPPER MIDDLE-INCOME	6.6%	1.3%	0.4%

Source: Authors' own estimation based on HIES 2016 data.

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National Bureau of Statistics
Ministry of Finance & Treasury
Male', Maldives