Calculating the standard of living of a household: one or several equivalence scales?

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Equivalence scales, used to compare the standard of living of households of different size and composition, take into account the economies of scale resulting from pooling income and expenditure within households. Two approaches can be used to estimate these scales: an "objective" approach based on modelling household consumption expenditure, or a "subjective" approach based on how households perceive their standard of living. This article focuses on the latter.

Using data from the 1995 to 2011 editions of the French Household Expenditure survey *(Budget de famille)* by Insee, estimations of equivalence scales highlight the sensitivity of results to the model specification, estimation coverage, the choice of subjective living standard indicators and the conventions used to calculate the cost of dependent children.

The subjective approach does not give a robust identification of a single equivalence scale. It does, however, provide a set of possible equivalence scales; for instance, the adult equivalent for a child under 14 ranges from 0.15 to 0.8, while standard equivalence scales are based on a convention, such as 0.3 for the OECD-modified equivalence scale. Thus, for studies using these instruments, or for public policy, it may be preferable to consider a set of equivalence scales rather than just a single scale.

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In order to study topics such as poverty or inequality, economists calculate the standard of living of households, defined as groups of individuals who share their income and expenditure. Comparing the standard of living of households requires taking into account the demographic composition of these households, their disposable income, and also any economies of scale obtained by pooling their income and expenditure. For example, between a couple with no children and a monthly income of €1,500 and a couple with two dependent children and a monthly income of €2,100, who has the higher standard of living? The second couple may have more income, but they have greater expenditure due to dependent children. In practice, the most common equivalence scales assign a "weight" to each individual in a household, representing the additional income required by the household for each additional individual in order to obtain the same standard of living as a household composed of a single individual. Given economies of scale, i.e. the fact that the needs of two (or three, etc.) people living together are not twice (or three times, etc.) those of a person living alone, the ratio of additional individuals to the additional income required to maintain the same standard of living is less than one: hence the weight assigned to an additional individual is always below 1. A household's standard of living is calculated by comparing its disposable income[1] with the sum of these weights (sometimes called the number of consumption units or "adult equivalents"). Weight values differ depending on the methodology and approach.

This paper will briefly summarise the most common equivalence scales and associated criticisms, and then focus on the problem of estimating these equivalence scales. The data used is taken from the latest editions (1995, 2001, 2006 and 2011) of the French Household Expenditure survey (*Budget de famille*) by Insee. The most recent publication on this topic in France is an article from the late 1990s (Hourriez & Olier, 1997), where the authors examined the relevance of changing the equivalence scale used up until that time for household income statistics and studies. Following on from this publication, our study analyses the benefit of using a set of equivalence scales rather than a single equivalence scale. The aim is to show that currently available methods do not allow us to rule on a single equivalence scale, but only give a possible range of coefficients. This instrument must therefore be used carefully.

A brief review of equivalence scales

The issue of equivalence scales goes back to the aftermath of the Second World War and the implementation of public policies to fight poverty. Economists have long studied the topic and this period saw the first articles proposing estimation methods (Prais, 1953; Friedman, 1952; Prais & Houthakker, 1955). The "Oxford scale" dominated the literature from the 1950s (see Hourriez & Olier, 1997) and an OECD report recommended its use in 1982, explaining why the literature also refers to it as the "OECD scale". This scale assigns the first adult in a household a weight of 1, each additional adult a weight of 0.7, and each child (a person under 14) a weight of 0.5. The sum of these weights gives the number of adult equivalents in the household. However, in the early 1990s, after a review of empirical research on the topic, the OECD opted for a new scale of reference, assigning each household a number of adult equivalents equal to the square root of the number (N) of individuals living in the household. Knowing the age of individuals is not necessary for calculations based on the "square root of N" scale, making it easier to use. [1]

In parallel, Eurostat, who produces harmonised European statistics, gradually replaced the Oxford scale throughout the 1990s with what is known as the "OECD-modified" scale (although the OECD seldom uses it). The OECD-modified" scale also began to appear in the literature (see Hagenaars et al., 1994). Compared to the Oxford scale, the OECD-modified scale gives a lower weight to additional individuals (see Table 1). This scale was adopted by Insee in the late 1990s for computing the standard of living of households, which in turn was used to calculate the poverty threshold and poverty rates[2]. Although this scale is in widespread use across most European countries, some researchers still use the Oxford scale. Some countries also favour other methods of defining the poverty line. In the United States, the poverty line is defined by the US Census Bureau on the basis of a basket primarily composed of food items[3].

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1. The sum of all household income (salaries and business income, property income, social security benefits, and net transfers from other households), net of compulsory contributions.

2. In France and for European statistics, the poverty threshold is currently set at 60% of the median standard of living. It was set at 50% until the late 1990s and many academic publications still use this threshold.

3. The value of this basket is modified each year in line with inflation. For an individual living alone, the poverty line was $1,026 dollars per month (€850 euros) in 2014 (excluding Alaska and Hawaii). In comparison, the poverty theshold was €1,007 per month in France the same year.

In theory, equivalence scales depend on the type of welfare system in question. They are influenced by the fact that some expenses are covered by the welfare system and others are borne by households. For example, in English-speaking countries where higher education is generally paid for by households, the cost of a child is probably higher (especially when aged over 18) than in a country like France where higher education is subsidised. Theoretically, an equivalence scale is valid for a given welfare and fiscal system, and may be distorted if the system changes. However, in practice, the OECD-modified scale and the Oxford scale have become international standards.

The equivalence scale concept and the assumptions on which it is based have long been the subject of various criticisms (e.g. see Lechêne, 1993). One criticism involves the implicit theoretical approach, referred to as the "unitary" approach to household behaviour, which assumes that the household maximises a utility function under a budget constraint. However, these two points can be challenged, as they contradict the principle of methodological individualism (Chiappori, 1992) and raise the question of how to combine the utilities of the different household members. On these issues, none of the solutions proposed in the literature is fully convincing (see Blackorby & Donaldson, 1993). Furthermore, the use of an equivalence scale implicitly assumes that the income of all members of the household is pooled and excludes the possibility of inequality within the household. All its members are presumed to have the same standard of living. This assumption can hide inequalities within households, e.g. between men and women or between parents and children. These diverse criticisms led to the emergence of "collective" approaches to the household (see, in particular, Chiappori, 1988; Browning et al., 1994; and for an informal presentation, Donni & Ponthieux, 2011). This approach explicitly recognises that households are composed of various individuals, each with their own preferences and utility function. A number of recent publications have introduced the concept of "indifference scale" which involves comparing the utility of a single individual in two different family contexts (Browning et al., 2013; Chiappori, 2016). European and French data on intra-household sharing of resources have shown that these resources might be pooled in significantly different ways and to various extent: in particular, couples are more likely to fully pool their income than other types of household. In France, for instance, less than two thirds of couples claim to fully pool their resources (Ponthieux, 2013).

Another common criticism of equivalence scales is that they tend to lead to the assumption that the "cost" of an additional individual is proportional to the household income. For example, using the OECD-modified scale, the cost of a child under 14 is estimated to be 0.3 times the income of someone living alone. In 2014, this represented approximately €300 per month for someone living alone with a standard of living close to the poverty line, €500 per month for a median standard of living and €900 per month for person at the ninth decile[4]. This assumption is highly debatable (Koulovatianos et al., 2004),

4. Here the poverty line is considered to be 60% of the median income. In 2014, the median standard of living of the French population was €20,150 per year with the final decile at €37,300 per annum (Argouarc'h & Boiron, 2016).

Table 1
Equivalence scales for various household composition

Household composition	Equivalence scale				
	Oxford		OECD-modified		Square root of N
Person living alone	1		1		1
Couple without children	1.7		1.5		1.41
Couple with children					
Age of children	Under 14	14 and over	Under 14	14 and over	
Couple + 1 child	2.2	2.4	1.8	2.0	1.73
Couple + 2 children	2.7	3.1	2.1	2.5	2.00
Couple + 3 children	3.2	3.8	2.4	3.0	2.23
Single parent + 1 child	1.5	1.7	1.3	1.5	1.41
Single parent + 2 children	2.0	2.4	1.6	2.0	1.73
Single parent + 3 children	2.5	3.1	1.9	2.5	2.00

Reading: with the Oxford scale, a couple without children needs an income of 1.7 x R in order to achieve the standard of living of someone living alone with an income R.

but rejecting it would mean having to define as many scales as there are standards of living.

Although these criticisms are substantiated and well-known, as yet no alternative methodology has emerged to compute standards of living (Canberra Group, 2011). This paper will therefore remain within the standard framework of equivalence scales (i.e. the unitary approach to the household).

Two approaches to estimating an equivalence scale

In the literature, two methods have been developed for estimating these scales: an "objective" approach and a "subjective" approach.

The objective approach involves modelling household demand for various goods as a function of both income and household composition. However, in order to be identified, these models require an identifying assumption, but this assumption is not testable with survey data (Blundell & Lewbel, 1991). In practice, this means that statisticians must define their own measure of a household's standard of living. Two major assumptions have been proposed in the literature. The first is the Engel curve (1857), whereby the standard of living of a household depends on the share of its budget spent on food. The greater the budget share spent on food, the lower the standard of living. The budget coefficient for food therefore determines a household's standard of living. This assumption was credible in the 19th century when food represented up to 80% of the household budget, but is much less so today in a context where the structure of consumption has become much more varied. The second is Rothbarth's assumption, whereby expenditure on goods exclusively consumed by adults could be used to measure a household's standard of living. In other words, the more a household spends (in absolute value) on the purchase of goods for adults, the higher its standard of living. The problem for statisticians is then to distinguish, among the household expenses, those made exclusively for the adults. In the literature, the goods the most often used are adult clothing or tobacco and alcohol expenditure.

While these assumptions have the advantage of being based on objective data (household consumption expenditure), they are open to criticism on several levels. Firstly, the choice of a measure of standard of living is by-and-large conventional, and the estimated scale therefore reflects the definition of the standard of living set *ex ante* by the statistician. Next, these assumptions do not take into account the changing preferences of households as they grow in size. For example, the birth of a child may lead a couple to change their lifestyle and significantly reduce their expenditure on "adult goods," without leading to a reduction in its standard of living. But even if the assumption made in defining the standard of living seems generally credible, just a slight deviation from reality can result in biased estimations.

The "subjective" approach, proposed for the first time in the literature by Kapteyn and Van Praag (1976), has been adopted in this paper. Its main advantage is that (unlike the objective method) estimations do not need be based on a definition of the standard of living set arbitrarily by the statistician (Hourriez & Olier, 1997). The standard of living assigned to each household is based either on the household's opinion of its own standard of living or on the population's average opinion of its standard of living. The variables used are therefore not household expenditure, but result from questions on the household's perception of their standard of living. In general, this approach has been used less often in the literature by economists, who are rather inclined to give greater credit to what individuals really do rather than to what they say they do (Accardo, 2007). However, various authors have adopted a subjective approach, based on questioning households directly on their standard of living (Flik & Van Praag, 1991) or on the income level they consider to be minimum, average or comfortable for a household such as theirs (Van der Bosch, 1996). In France, various research projects have used this approach, with studies published by Bloch and Glaude (1983), Glaude and Moutardier (1991) and Hourriez and Olier (1997), all of which are based on different editions of the French Household Expenditure survey. This paper contributes to the existing literature in three ways. Firstly, estimations are based on the latest editions of the survey, allowing us to explore recent changes in the estimated coefficients. Secondly, unlike previous empirical work, confidence intervals are provided. Finally, a large number of robustness tests have been conducted.

Estimations based on a subjective approach

In the French Household Expenditure survey *Budget de famille*, three variables can be used

to determine a household's perceived standard of living: AISE, NIVEAU and RMINI. The first two are based on asking households questions on how they perceive their financial situation and standard of living respectively. The third asks them to assess the minimum income they consider necessary, for a household like their own,to meet their needs (Box 1).

More precisely, the subjective method is based on modelling an indicator of the household's standard of living or unobserved utility function, U, which is an increasing function of its income R and a decreasing function of its size N. The parameters of this standard of living indicator U are estimated using an ordered logistic model for the variables AISE and NIVEAU. The indicator represents the model's latent variable. Socio-demographic variables are also introduced in order to control for the observed heterogeneity of households as well as possible. The standard of living indicator is written as:

$$U(R,N) = \alpha \cdot \log(R) + \beta \cdot N + \gamma \cdot \log N + controls + \varepsilon$$

The idea is to identify the additional income required to maintain the household's standard of living with an additional dependent person – in other words, find the multiplication factor $m(N)$ by which the income R of an individual living alone must be multiplied for him or her to maintain the same standard of living with N-1 additional dependent individuals (spouse or children). The following equation is solved:

$$U(R,1) = U\left(R \cdot m(N), N\right)$$

The following type of multiplication factors or equivalence scales are obtained:

$$m(N) = N^{\frac{-\gamma}{\alpha}} \cdot e^{(1-N)\frac{\beta}{\alpha}}$$

In order to take into account the age of the children, Hourriez and Olier define N as the "adjusted" household size, with $N_{under\ 14}$ representing the number of children under 14 in the household and $N_{14\ and\ over}$ representing the

Box

HOUSEHOLDS' PERCEPTION OF THEIR STANDARD OF LIVING IN THE FRENCH HOUSEHOLD EXPENDITURE SURVEY (*BUDGET DE FAMILLE*)

The French Household Budget survey (*Budget de famille*) is a survey conducted by Insee every five years since 1979, covering the population living in private households. The survey was conducted in 1979, 1985, 1989, 1995, 2001, 2006 and 2011. Its main aim is to study the income and consumption expenditure of households. There are also questions on the household's perception of its financial situation. Three variables, AISE, NIVEAU and RMINI, can be used to estimate an equivalence scale using the subjective method.

The *variable AISE* corresponds to the following question: "Please tell me which of the following options best describes your budget"

- You are comfortably off (10%)
- You manage (29%)
- You manage, but you have to be careful (43%)
- It's difficult to get by (16%)
- You cannot get by without contracting debts (3%)

The *variable NIVEAU* was introduced for the 1995 survey. It corresponds to the following question: "How would you qualify your standard of living?"

- Very high (0.6%)
- High (6%)
- Moderately high (46%)
- Moderately low (32%)
- Low (12%)
- Very low (4%)

For these two variables, the percentage of responses for each category in the 2011 survey are given in brackets.

The *variable RMINI* corresponds to the following question: "In your opinion, what is the minimum monthly income currently required for a household like your own to simply meet its needs?"

Unlike the two other variables, RMINI is a continuous variable and has been present in the same form in all editions of the survey since 1979. In the 2011 survey, the mean level of the variable was €2,230 per month (differing of course with the household size). This variable is more difficult to use since it does not directly refer to the household's perceived standard of living.

Hourriez (1996) shows that the answers given by households to these three questions are consistent with one another (strong correlations) and that they vary as expected according to some other economic or demographic variables (in particular, the income and the number of individuals living in the household).

number of people (children and adults) aged 14 or over in the same household. After estimating the weighting factor for children under 14, the authors adopted the following equation for the adjusted household size:

$$N = 0.55 \cdot N_{under14} + N_{14and over}$$

Initially, we will keep this definition of the adjusted household size with a weighting factor of 0.55 in order to use a methodology comparable to that of Hourriez and Olier. This choice of a weighting factor of 0.55 and an age threshold of 14 for children will be discussed in the second part of the study.

Unlike the AISE and NIVEAU variables, RMINI is a continuous variable. In this instance, following the method proposed by Kapetyn and Van Praag (1976), the indicator of the household's standard of living is defined as $U = \log\left(\frac{R}{RMINI}\right)$ where R remains the household income. The household's standard of living is therefore determined using the ratio between effective disposable income and the income deemed necessary to meet the household's needs. A household with an income below what it considers the minimum to meet its needs will be assigned a low standard of living. Likewise, if its income is much higher than this minimum income, its standard of living will be considered high. The estimated model is a linear regression:

$$\log(RMINI) = constant + \alpha \cdot \log(R) + \beta \cdot N + \gamma \cdot log(N) + controls + \varepsilon$$

which is equivalent to:

$$U(R,N) = \log\left(\frac{R}{RMINI}\right) = -constant + (1-\alpha) \cdot \log(R) - \beta \cdot N - \gamma \cdot \log(N) - controls - \varepsilon$$

The associated equivalence scales take the form of:

$$m(N) = N^{\frac{-\gamma}{\alpha-1}} \cdot e^{(1-N)\frac{\beta}{\alpha-1}}$$

To begin, we use the exact same estimation method as the one used by Hourriez and Olier (hereafter H&O 1997). The models, variables used (Appendix 1) and the scope of the estimations are therefore identical. The sample includes all households consisting of an individual living alone or a couple with or without dependent children under 25. We also keep the same definition of income as the authors (that is, self-reported income before tax). The objective is two-fold. Firstly, to study changes in the equivalence scales over time by conducting the same estimations with more recent data. Secondly, to provide confidence intervals for the coefficients (which the other authors were not able to do). These confidence intervals are obtained using the delta method, which provides variance estimators for non-linear transformations of estimated parameters. These intervals are valuable for assessing changes in the equivalence scales between 1995 and 2011. H&O 1997 chose to focus primarily on the variable AISE in their calculations, which is why the results using this indicator are presented first (Table 2).

Given the confidence intervals, it is not possible to conclude that the equivalence scales follow a linear evolution between 1995 and 2011. Nevertheless, these confidence intervals give an idea of the accuracy of the estimations. For example, using data from the 2011 survey, the confidence interval for a couple with 2 dependent children over 14 is between 2.44 and 3.02.

To assess the robustness of estimations contributing to the choice of the standard of living indicator, similar estimates were made using the variables NIVEAU and RMINI for the most recent survey (Table 3). This shows that the results present a high level of sensitivity. The estimations are even sometimes contradictory when the confidence intervals do not match. This is especially true for estimations using the variable RMINI, where the confidence intervals are much narrower than when the estimations are based on other indicators[5]. The equivalence scale obtained using the variable AISE is relatively close to the OECD-modified scale, despite the wide confidence intervals. With the variable NIVEAU, however, a smaller number of consumption units is assigned to families, and NIVEAU seems to result in larger economies of scale than AISE. The variable RMINI shows a non-linear shape: each additional individual adds a significantly decreasing number of consumption units (0.48 for the first, then 0.26, 0.11 and finally 0.02 for the fourth).

5. This is explained by the continuous nature of the RMINI variable.

The sensitivity of the estimations to the chosen living standard indicator raises the question of the information captured by these variables. NIVEAU seems to question households more directly on their standard of living, but assumes that this complicated concept has been understood by respondents. The median categories ("relatively high" and "relatively low" standard of living) are chosen by the vast majority of households (almost 80%), which makes it difficult to distinguish between standards of living. The variable AISE poses other problems. It introduces almost objective considerations regarding management of the household finances, making direct reference to budget and the notion of debt. These considerations may be disconnected from a household's perception of its standard of living. For example, a well-off household may report a "high" or "very high" standard of living and reply "It's tight but we manage". Finally, for the variable RMINI, the respondents may have understood "income" to be a "perceived" income, including salary and major transfer income (unemployment benefits and pension), but ignoring other social benefits (family, housing and child benefits, etc.)[6]. The subjective approach choses to calculate equivalence scales using the "utility" (or standard of living) reported by the household. If a child is

6. *This possibility was proposed by Jean-Michel Hourriez (1996).*

Table 2
Equivalence scales estimated using the indicator AISE, H&O1997 method

Household composition	*OECD-modified scale*	H&O 1997 1995	1995	2001	2006	2011
Individual living alone	*1*	1	1	1	1	1
Couple without children	*1.5*	1.42	1.42 [1.33 ; 1.50]	1.44 [1.37 ; 1.52]	1.51 [1.43 ; 1.59]	1.51 [1.41 ; 1.61]
Couple + 1 child aged 14 or over	*2.0*	1.86	1.86 [1.72 ; 2.00]	1.87 [1.75 ; 1.98]	2.02 [1.90 ; 2.15]	2.08 [1.91 ; 2.24]
Couple + 2 children aged 14 or over	*2.5*	2.38	2.37 [2.16 ; 2.59]	2.31 [2.13 ; 2.49]	2.60 [2.38 ; 2.81]	2.73 [2.44 ; 3.02]
Couple + 3 children aged 14 or over	*3.0*	3.00	2.98 [2.59 ; 3.36]	2.79 [2.46 ; 3.11]	3.24 [2.85 ; 3.63]	3.51 [2.95 ; 4.06]

Note: 95% confidence intervals (delta method) are shown in square brackets.

Reading: using H&O 1997 method for the 2011 French Household Expenditure survey, a couple without children needs an income of 1.51 x R in order to achieve the standard of living of someone living alone with an income R.
Coverage: households composed of people living alone, couples without children or with children under 25, and single-parent families with children under 25, representing 8,820 households in 1995, 9,479 households in 2001, 9,539 households in 2006 and 14,053 households in 2011.
*Source: Hourriez & Olier (1997) and Insee, Household Expenditure survey (*Budget de famille*) 1995, 2001, 2006, 2011.*

Table 3
Equivalence scales estimated for the three indicators of living standard, H&O1997 method

Household composition	Equivalence scale			Estimation for the three indicators		
	Oxford	OECD-modified	Square root of N	RMINI	NIVEAU	AISE
Individual living alone	1	1	1	1	1	1
Couple without children	1.5	1.7	1.41	1.48 [1.47 ; 1.50]	1.32 [1.23 ; 1.41]	1.51 [1.41 ; 1.61]
Couple + 1 child aged 14 or over	2.0	2.4	1.73	1.74 [1.72 ; 1.76]	1.60 [1.48 ; 1.73]	2.08 [1.91 ; 2.24]
Couple + 2 children aged 14 or over	2.5	3.1	2.00	1.85 [1.83 ; 1.87]	1.89 [1.70 ; 2.07]	2.73 [2.44 ; 3.02]
Couple + 3 children aged 14 or over	3.0	3.8	2.24	1.87 [1.84 ; 1.89]	2.18 [1.87 ; 2.49]	3.51 [2.95 ; 4.06]

Note: 95% confidence intervals (delta method) are shown in square brackets.

Reading: using H&O 1997 estimation method with the indicator NIVEAU, a couple needs an income of 1.32 x R in order to achieve the standard of living of someone living alone with an income R.
Coverage: households composed of people living alone, couples without children or with children under 25, and single-parent families with children under 25, representing 14,053 households.
*Source: Insee, Household Expenditure survey (*Budget de famille*) 2011.*

wanted and creates surplus "utility", the "cost" of the child could be negative (if the increase in utility exceeds that of the expenditure associated with the child). The variable NIVEAU records a standard of living that could be considered equal to the total utility of a household, whereas the AISE variable focuses more on financial aspects. In the end, although it is less obvious than with the objective approach, statisticians implicitly define the standard of living within a subjective method by formulating survey questions in a certain way.

The second stage of this study aims to improve the methodology adopted by Hourriez and Olier. A previous analysis of the main determinants of perceived standard of living (Martin, 2015) lead to the following choices:

- The coverage of the estimations is restricted. Specifically, single-parent families and households with a reference individual aged over 64 have been excluded. These households present specific response behaviours to the questions AISE and NIVEAU (Martin & Périvier, 2015). The sample has therefore been limited to people living alone and couples whose reference individual was aged between 25 and 64 at the time of the survey.

- Secondly, the notion of disposable household income is preferred to pre-tax income. In the 2011 Household Expenditure survey, the household income is derived from tax data, ensuring greater reliability.

- Finally, two additional control variables have been introduced (Appendix 1) to take into account recent changes to the household's standard of living and its net worth. These variables are important in determining perceived standard of living (Martin 2015). These additions will be referred to hereafter as the "supplemented H&O" method.

Once again, the results show that the choice of one indicator over another produces different estimates. They also indicate that estimations are extremely sensitive to the model specification (see Tables 3 and 4). Even marginal changes in the sample, the definition of income or the control variables result in different estimations. For example, for the variable AISE, a household composed of a couple and two children aged 14 or over is attributed a coefficient of 3.27 with the supplemented H&O method, compared to 2.73 with the H&O 1997 method. To gain a better understanding of the reason behind the deviations between the two methods, we performed two other estimations, first varying only the sample, and then the sample and the definition of income. The results (Appendix 2) show that most variations can be explained by the control variables added.

The results obtained with the RMINI indicator are very different from those obtained with AISE and NIVEAU. With this variable, each additional person contributes a strongly decreasing number of consumption units. In the linear model estimation for the RMINI variable,

Table 4
Equivalence scales estimated for the three indicators of living standard, H&O 1997 supplemented method

Household composition	RMINI		NIVEAU		AISE	
Individual living alone	1		1		1	
Couple without children	1.43 [1.39 ; 1.48]		1.33 [1.20 ; 1.47]		1.56 [1.42 ; 1.70]	
Couple with children						
Age of children	Under 14	14 and over	Under 14	14 and over	Under 14	14 and over
Couple + 1 child	1.57 [1.52 ; 1.61]	1.64 [1.58 ; 1.69]	1.51 [1.42 ; 1.70]	1.68 [1.49 ; 1.87]	1.93 [1.74 ; 2.12]	2.29 [2.05 ; 2.63]
Couple + 2 children	1.65 [1.61 ; 1.70]	1.71 [1.64 ; 1.77]	1.70 [1.62 ; 1.79]	2.07 [1.80 ; 2.33]	2.38 [2.12 ; 2.63]	3.27 [2.84 ; 3.70]
Couple + 3 children	1.70 [1.65 ; 1.76]	1.69 [1.61 ; 1.78]	1.90 [1.81 ; 2.00]	2.51 [2.06 ; 2.95]	2.89 [2.55 ; 3.23]	4.60 [3.73 ; 5.48]

Note: 95% confidence intervals (delta method) are shown in square brackets.

Reading: using H&O supplemented method with the indicator NIVEAU, a couple needs an income of 1.33 x R in order to achieve the same standard of living the standard of living of someone living alone with an income R.
Coverage: all households composed of individuals living alone, couples without children or with at least one dependent child under 25. The person of reference must be older than 25 and younger than 64 at the time of the survey. The estimation includes 8,601 households for the variable RMINI, 9,020 households for the variable AISE and 8,932 households for the variable NIVEAU (differences are due to non-response).
*Source: Insee, Household Expenditure survey (*Budget de famille*) 2011.*

the β and γ parameters, associated with the *N* and *log(N)* variables respectively, are of opposite signs. The equivalence scale obtained does not therefore strictly increase as a function of N. This counter-intuitive result raises questions about the relevance of the indicator. In a study on RMINI, Gardes and Loisy (1997) demonstrate that the response behaviour of households varies significantly according to their income. For households at both ends of the income distribution (the least and most well-off households), RMINI is more an assessment of basic requirements. For intermediate households on the other hand, RMINI is more about demanding a higher standard of living. These differences suggest that the relationship between a household's income and RMINI is not a reliable indicator of the standard of living. For this reason, in the rest of this study we will focus on the indicators based on AISE and NIVEAU.

What age threshold for children?

The Oxford scale and OECD-modified scale assume a shift in the "cost of a child" at 14 years old. For example, for the OECD-modified scale, a child under 14 represents 60% of the cost of an adult[7]. From the age of 14, a child is assumed to "cost" as much as an adult. This threshold may have been relevant in the 1950s, when the household budget was primarily spent on food expenditure. The age of 14 represents the beginning of adolescence, when food requirements start to be comparable to that of adults. However, in recent years, expenditure on higher education has significantly increased, whereas only a limited number of households were affected in the 1950s. It therefore seems possible that children over 18 (in higher education) generate additional expenses for their family and that the cut-off point in the cost of a child is gradually shifting towards the age of 18.

All the results presented above are based on two major assumptions: the cut-off point for the cost of a child is set at the age of 14, and the relative cost of a child under 14 as compared to an adult is 0.55. These two assumptions must be examined to greater depth. H&O 1997 proposes the following ordered logistic model for the variable AISE in order to estimate the cost of children according to their age:

$$U(R,N) = \alpha \cdot \log(R) + \beta_1 \cdot N_{0-4} + \beta_2 \cdot N_{5-9} + \beta_3 \cdot N_{10-14} + \beta_4 \cdot N_{15-19} + \beta_5 \cdot N_{19-24} + \beta_6 \cdot N_{adults} + controls + \varepsilon$$

where the variables N_{x-y} represent the number of dependent children in the household aged between x and y, and *R* the household's pre-tax income. The cost of a child in the x-y age bracket corresponds to the factor *c* by which the income of a single parent with a dependent child in this age bracket should be multiplied for this household to have the same standard of living as an individual living alone. The equation to solve is:

$$U\left(Rc, N_{x-y}=1\right) = U\left(R, N=0\right)$$

to give: $c = e^{-\beta_{x-y}/\alpha}$, where β_{x-y} represents the parameter associated with the variable N_{x-y}. The parameter *c* gives the cost of a child as a percentage of the income of an individual living alone. In order to generate comparable results, the H&O 1997 method was used with data from the latest editions of the French Household Expenditure survey (Table 5).[7]

The confidence intervals are relatively wide, making it difficult to identify any significant change to the cost of a child per age group between 1979 and 2011. Nevertheless, the 2011 survey stands out with an especially high cost of a child aged 0 to 4 and a relatively low cost for 20-24 year olds. The same calculation was made using the indicator NIVEAU to test the robustness of these results (Table 6).

Once again, the two living standard indicators (AISE and NIVEAU) give different estimates. For example, for the 2011 survey, the perceived cost of a child aged 10 to 14 calculated using the variable NIVEAU is not significantly different from 0 (Table 6), unlike the estimate calculated using the variable AISE (Table 5). The perceived cost of a child is generally lower with the variable NIVEAU than with the variable AISE. There seem to be two age thresholds after which child costs increase. The first is around 14 years old and the second around 20. However, considering the values of the confidence intervals and the sensitivity of the estimation to the year of the survey, it is not possible to choose between one or the other of these thresholds. In the remainder of this study, the 14 year-old threshold limit has therefore been retained.

7. 0.3/0.5=0.6

The relative cost of a child under 14, expressed as μ, is used as follows for calculating the adjusted household size:

$$N = \mu \cdot N_{under14} + N_{14\ and\ over}$$

μ represents the ratio between the cost of a child under 14 and the "cost" of an adult. $N_{under\ 14}$ represents the number of children aged under 14 in the household and $N_{14\ and\ over}$ represents the number of individuals (children and adults) aged 14 or over in the same household. Hourriez and Olier (1997) estimate μ based on the variable AISE and using the following ordered logistic model:

$$U(R,N) = \alpha \cdot \log(R) + \beta \cdot N_{14 and over} + \gamma \cdot N_{under14} + controls + \varepsilon$$

Table 5
Estimation of the perceived cost of an additional dependent individual according to his or her age, H&O 1997 method with the indicator AISE (%)

	Hourriez and Olier (1997) results				Estimation using the method H&O 1997			
Additional individual aged:	1979	1985	1989	1995	1995	2001	2006	2011
Under 5	21	20	18	12	21 [14 ; 28]	18 [12 ; 25]	17 [10 ; 24]	32 [21 ; 42]
5 to 9	16	15	16	11	10 [4 ; 17]	17 [10 ; 23]	20 [14 ; 27]	22 [12 ; 31]
10 to 14	22	18	20	18	18 [14 ; 28]	13 [7 ; 18]	12 [6 ; 19]	17 [8 ; 26]
15 to 19	29	34	28	28	23 [15 ; 30]	19 [12 ; 25]	25 [18 ; 32]	29 [18, 40]
20 to 24	45	38	49	41	36 [26 ; 46]	37 [27 ; 48]	42 [30 ; 53]	32 [18 ; 46]
25 and over	43	47	45	44	42 [32 ; 52]	44 [36 ; 52]	50 [41 ; 58]	47 [37 ; 58]

Note: 95% confidence intervals (delta method) are shown in square brackets.

Reading: with the living standard indicator AISE, an individual with a child aged under 5 needs an income 32% higher than an individual living alone in order to achieve the same standard of living.
Coverage: households composed of people living alone, couples without children or with at least one dependent child under 25, and single-parent families with at least one dependent child under 25. The estimation includes 8,820 households for 1995, 9,479 households for 2001, 9,539 households for 2006 and 14,053 households for 2011.
*Source: Hourriez & Olier (1997) and Insee, Household Expenditure survey (*Budget de famille*) 1995, 2001, 2006, 2011.*

Table 6
Estimation of the perceived cost of an additional dependent individual according to his or her age, H&O 1997 method with the indicator NIVEAU (%)

Additional individual aged:	1995	2001	2006	2011
Under 5	20 [14 ; 27]	17 [11 ; 24]	14 [7 ; 21]	18 [9 ; 27]
5 to 9	8 [3 ; 13]	8 [3 ; 13]	12 [6 ; 18]	13 [5 ; 22]
10 to 14	18 [13 ; 24]	7 [2 ; 13]	10 [4 ; 17]	3 [-3 ; 11]
15 to 19	12 [6 ; 18]	16 [10 ; 21]	17 [10 ; 23]	18 [10 ; 26]
20 to 24	26 [18 ; 33]	19 [12 ; 26]	27 [18 ; 37]	21 [10 ; 33]
25 and over	39 [30 ; 47]	34 [27 ; 41]	35 [27 ; 43]	31 [22 ; 40]

Note: 95% confidence intervals (delta method) are shown in square brackets.

Reading: using the living standard indicator NIVEAU, an individual with a child under 5 needs an income 18% higher than an individual living alone in order to achieve the same standard of living.
Coverage: all households composed of people living alone, couples without children or with at least one dependent child under 25, and single-parent families with at least one dependent child under 25. The estimation includes 8,682 households for 1995, 9,422 households for 2001, 9,483 households for 2006 and 13,897 households for 2011.
*Source: Insee, Household Expenditure survey (*Budget de famille*) 1995, 2001, 2006, 2011.*

The relative cost of a child under 14 is given by the equation $\mu = \frac{\gamma}{\beta}$.

Working with the H&O 1997 methodology, estimations of μ obtained using the latest editions of the survey can be used to explore changes in this parameter over time (Table 7).

Hourriez and Olier finally adopted a value of 0.55 for the parameter μ. This study also initially adopted the same value in order to provide comparable results. However, the estimations underpinning this choice are fragile (Table 7). Depending on the survey edition, the living standard indicator adopted, and taking into account the confidence intervals, the possible values of the parameter μ vary between 0.35 and 0.96. The value selected for the parameter itself has a major impact on the estimation of equivalence scales, as it determines the adjusted household size. In order to assess the sensitivity of estimations to the value adopted for the parameter μ, a number of estimations were made for various values of the parameter. These estimations are based on the indicator AISE, using the latest edition of the survey and applying the "supplemented H&O method." This time, the results appear to be relatively robust (Table 8).

A final estimation, which aims to be as precise as possible (i.e. without considering the parameter μ as necessarily set at 0.55, and using the

Table 7
Estimation of the relative cost of a child under 14, H&O 1997 method with the indicators AISE and NIVEAU

	Results Hourriez and Olier (1997)				Estimations with the H&O 1997 method			
	1979	1985	1989	1995	1995	2001	2006	2011
AISE	0.54	0.55	0.56	0.44	0.54 [0.41 ; 0.67]	0.57 [0.44 ; 0.70]	0.56 [0.43 ; 0.59]	0.77 [0.57 ; 0.96]
NIVEAU	-	-	-	-	0.71 [0.54 ; 0.87]	0.54 [0.38 ; 0.71]	0.59 [0.42 ; 0.76]	0.60 [0.35 ; 0.86]

Note: 95% confidence intervals (delta method) are shown in square brackets.

Reading: in 2011, using the indicator NIVEAU and H&O 1997 method, the cost of a child under 14 relative to an adult is 0.60.
Coverage: all households composed of people living alone, couples without children or with at least one dependent child under 25, and single-parent families with at least one dependent child under 25. For AISE, the estimation includes 8,820 households for 1995, 9,479 households for 2001, 9,539 households for 2006 and 14,053 households for 2011. For NIVEAU, the estimation includes 8,682 households for 1995, 9,422 households for 2001, 9,483 households for 2006 and 13,897 households for 2011 (differences are due to non-response).
*Source: Hourriez & Olier (1997) and Insee, Household Expenditure survey (*Budget de famille*) 1995, 2001, 2006, 2011.*

Table 8
Estimation of equivalence scales using the indicator AISE and the H&O supplemented method with different values adopted for the parameter , 2011

Household composition	$\mu = 0.40$		$\mu = 0.55$		$\mu = 0.70$	
Individual living alone	1		1		1	
Couple without children	1.66 [1.54 ; 1.80]		1.56 [1.42 ; 1.70]		1.51 [1.36 ; 1.65]	
Couple with children						
Children age	Under14	14+	Under14	14+	Under14	14+
Couple + 1 child	1.95 [1.90 ; 2.01]	2.42 [2.17 ; 2.66]	1.93 [1.74 ; 2.12]	2.29 [2.05 ; 2.63]	1.95 [1.84 ; 2.05]	2.17 [1.93 ; 2.42]
Couple + 2 children	2.26 [2.15 ; 2.36]	3.31 [2.85 ; 3.76]	2.38 [2.12 ; 2.63]	3.27 [2.84 ; 3.70]	2.50 [2.32 ; 2.68]	3.08 [2.68 ; 3.47]
Couple + 3 children	2.58 [2.43 ; 2.73]	4.39 [3.49 ; 5.29]	2.89 [2.55 ; 3.23]	4.60 [3.73 ; 5.48]	3.19 [2.93 ; 3.44]	4.32 [3.60 ; 5.05]

Note: 95% confidence intervals (delta method) are shown in square brackets.

Reading: using H&O supplemented method with the indicator AISE, setting the relative cost of a child under 14 at 0.40, a couple needs an income of 1.66 x R in order to achieve the standard of living of someone living alone with an income R.
Coverage: all individuals living alone, couples without children or at least one dependent child under 25. The person of reference is over 25 and under 64 at the time of the survey. The estimation includes 9,020 households.
*Source: Insee, Household Expenditure survey (*Budget de famille*) 2011.*

supplemented H&O method) was made, using the latest edition of the survey. The parameter μ is estimated using the method presented above. Two confidence intervals are provided. The first is calculated using the delta method, considering the parameter μ fixed at the value resulting from its estimation. The second is obtained by bootstrap (999 replications). At each iteration, a sample is selected with replacement. A first estimation of the parameter μ is made using this sample, followed by a second to estimate the coefficients of the equivalence scale. For the second estimation, the adjusted household size (*N*) is recalculated using the estimate of μ. It is then possible to deduce a standard deviation. To estimate the confidence interval, this method takes into account the uncertainty inherent to estimation of the parameter μ. The deviation between the two intervals gives an assessment of uncertainty in the estimation of coefficients, linked to uncertainty in the estimation of the parameter μ (Table 9).

On the basis of this latest estimation, it is possible to propose a set of possible equivalence scales, between an upper scale and a lower scale (Table 10). This is achieved by taking into account both the confidence intervals and the sensitivity of the estimation to the chosen living standard indicator. For the sake of simplicity, a linear form is chosen, which dissociates the consumption units for children under 14 from those for adults. The upper scale is estimated by setting the upper confidence interval limit at 95% for each family situation. The number of consumption units considered is 1.64 for a

Table 9
Estimation of equivalence scales for the indicators NIVEAU and AISE, with prior estimation of the parameter (H&O 1997 supplemented method), 2011

Living standard indicator	NIVEAU		AISE	
Estimate of μ	0.74 [0.35 ; 1.12]		0.88 [0.65 ; 1.11]	
Individual living alone	1		1	
Couple without children CI, set value of μ CI, estimated value of μ	1.32 [1.18 ; 1.44] [1.17 ; 1.45]		1.50 [1.37 ; 1.64] [1.37 ; 1.64]	
Couple with children *Children Age*	*Under 14*	*14+*	*Under 14*	*14+*
Couple + 1 child CI, set value of μ CI, estimated value of μ	1.54 [1.43 ; 1.65] [1.36 ; 1.72]	1.62 [1.44 ; 1.81] [1.41 ; 1.84]	2.02 [1.90 ; 2.14] [1.81 ; 2.22]	2.09 [1.87 ; 2.31] [1.84 ; 2.35]
Couple + 2 children CI, set value of μ CI, estimated value of μ	1.78 [1.62 ; 1.94] [1.53 ; 2.03]	1.96 [1.72 ; 2.20] [1.65 ; 2.27]	2.63 [2.43 ; 2.83] [2.30 ; 2.97]	2.82 [2.49 ; 3.16] [2.39 ; 3.25]
Couple + 3 children CI, set value of μ CI, estimated value of μ	2.04 [1.84 ; 2.23] [1.68 ; 2.39]	2.33 [1.96 ; 2.70] [1.86 ; 2.81]	3.39 [3.10 ; 3.67] [2.82 ; 3.96]	3.74 [3.17 ; 4.31] [2.99 ; 4.50]

Note: two confidence intervals (CI) are presented. The first, for the set value of μ, is computed using the delta method. The second, for the estimated value of μ, incorporates the uncertainty inherent to the estimation of this parameter and is computed by bootstrap (999 replications).

Reading: using H&O supplemented method with the living standard indicator AISE, the relative cost of a child under 14 is estimated at 0.88. Furthermore, when this cost is fixed at 0.88, in order to achieve the same standard of living as someone living alone with an income R, a couple needs an income of 1.50 x R.
Coverage: all individuals living alone, couples without children or at least one dependent child under the age of 25. The reference person must be older than 25 and younger than 64 at the time of the survey. The estimation includes 9,020 households for the variable AISE and 8,932 households for the variable NIVEAU (the difference is due to non-response).
*Source: Insee, Household Expenditure survey (*Budget de famille*) 2011.*

Table 10
Set of equivalence scales: coefficients for an additional individual age according to his or her age

	Child under 14	Adults and children aged 14 or over
Upper scale	0.8	0.9
Central scale (OECD-modified scale)	0.3	0.5
Lower scale	0.15	0.2

Reading: the upper scale assigns 0.8 consumption units to each dependent child under 14 in the household.

couple, 2.35 for a couple with one child aged 14 or over, 3.25 for a couple with two children 14 or over and 4.50 for a couple with three children 14 or over. The number of consumption units attributed to each additional adult or child 14 or over is therefore 0.64 for the first, 0.71 for the second, 0.9 for the third and 1.25 for the fourth, representing an average of 0.875, rounded up to 0.9. The same reasoning is used to deduce the number of consumption units for children under 14. A symmetric method is used to establish the lower scale. The centre scale is obtained using the mean estimates calculated on the basis of the indicators NIVEAU and AISE[8].

* *
*

The aim of this paper is to underline the limitations inherent to the estimation of an equivalence scale. The objective approach is problematic, as statisticians must choose their own definition of a household's standard of living. The subjective approach raises other problems. Firstly, the confidence intervals for the estimated coefficients are particularly wide. Next, the results of the estimations depend on which living standard indicator is chosen. It is difficult to choose one rather than the other. Finally, these estimates are also sensitive to model specifications. The subjective approach does not clearly identify a single equivalence scale. It would be preferable to speak of a set of possible estimates, defined by the confidence intervals obtained from several estimations and to use a set of equivalence scales, built according to the principles set out in this paper. This paper's major contribution is the development of such a set of scales. Researchers who use equivalence scales in their work should apply caution when using these instruments. When selecting one scale across the entire set of possible scales, it is preferable to systematically test the robustness of the results obtained. Legislators should also be aware that the choice of the OECD-modified scale – used to develop a number of social indicators (such as poverty rates or the definition of the poverty line) and certain public policies – is largely a conventional choice.[8] □

8. For example, the number of units adopted for a couple without children is the mean of 1.32 and 1.50, i.e. 1.41. This type of calculation would have created a slightly higher coefficient for children under 14 (0.35), but we chose to retain 0.3 in line with the OECD-modified scale.

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APPENDIX 1

CONTROL VARIABLES FOR THE ESTIMATED MODELS

The following control variables are used in estimations using the method Hourriez and Olier (H&O 1997):

- the employment status of the person of reference of the household: employment (reference) unemployment, retirement and non-employment – excluding retirement;

- the "socio-occupational" category of the person of reference of the household: managers, self-employed workers, intermediate professions, manual workers, blue collar workers (reference);

- the housing status of the household: homeowners with and without a mortgage, tenants (reference);

- age brackets: 18-29 years old, 30-39, 40-49 (reference), 50 and over;

- a dummy variable for single-parent families;

- a dummy variable for Paris residents;

- a dummy variable for one-earner families.

For the method "Hourriez and Olier supplemented", the following variables are added:

- the household's view of recent changes to its standard of living: significant drop, slight decrease, stability (reference), increase.

- the household's net worth: below €100,000, between €100,000 and €500,000 (reference), over €500,000.

APPENDIX 2

ESTIMATIONS OF EQUIVALENCE SCALES WITH REFERENCE TO THE METHOD H&O 1997, CHANGING FIRST THE COVERAGE AND THEN THE COVERAGE AND THE DEFINITION OF INCOME

Table A.1
Change of the coverage only

Household composition	RMINI	NIVEAU	AISE
Individual living alone	1	1	1
Couple without children	1.48 [1.46 ; 1.50]	1.28 [1.17 ; 1.39]	1.43 [1.32 ; 1.54]
Couple + 1 child aged 14 or over	1.73 [1.71 ; 1.75]	1.54 [1.39 ; 1.69]	1.93 [1.75 ; 2.10]
Couple + 2 children aged 14 or over	1.84 [1.82 ; 1.86]	1.80 [1.60 ; 2.00]	2.54 [2.26 ; 2.80]
Couple + 3 children aged 14 or over	1.85 [1.82 ; 1.87]	2.08 [1.76 ; 2.40]	3.29 [2.79 ; 3.79]

Note: 95% confidence intervals (obtained using the delta method) are shown in square brackets.

Reading: When only modifying the range of the estimations but using all other aspects of the method H&O 1997, with the indicator NIVEAU, a couple needs an income 1.28 times that of an individual living alone (1.28 x R) in order to achieve the same standard of living.
Coverage: all individuals living alone, couples without children or with at least one dependent child under the age of 25. The person of reference must be between 25 and 64 years old at the time of the survey. The estimate includes 8,601 households for the RMINI variable, 9,020 households for the variable AISE and 8,932 households for the variable NIVEAU. The differences are due to non-response.
*Source: French Household Expenditure survey (*Budget de famille*) 2011, Insee.*

Table A.2
Change of the coverage and the definition of income

Household composition	RMINI	NIVEAU	AISE
Individual living alone	1	1	1
Couple without children	1.48 [1.45 ; 1.49]	1.28 [1.16 ; 1.41]	1.46 [1.33 ; 1.58]
Couple + 1 child aged 14 or over	1.72 [1.70 ; 1.73]	1.48 [1.41 ; 1.75]	2.02 [1.83 ; 2.21]
Couple + 2 children aged 14 or over	1.81 [1.79 ; 1.83]	1.91 [1.67 ; 2.13]	2.75 [2.44 ; 3.06]
Couple + 3 children aged 14 or over	1.81 [1.78 ; 1.84]	2.28 [1.90 ; 2.66]	3.70 [3.10 ; 4.30]

Note: see Table A.1.

Reading: When modifying both the range of the estimations and the definition of income, but following all other aspects of the method H&O 1997, with the indicator NIVEAU, a couple needs an income 1.28 times that of an individual living alone (1.28 x R) in order to achieve the same standard of living.
Coverage: see Table A.1.
*Source: French Household Expenditure survey (*Budget de famille*) 2011, Insee.*