

Chapter 8

Framework for integrated analysis

This chapter first shows the importance of considering life cycles when analysing data on income, consumption and wealth. It then provides an overview of selected tools that can be used for the integrated analysis of household income, consumption and wealth measures, as well as the use of equivalence scales in each dimension. The chapter then presents examples of the joint analysis of income and wealth data, and of income and consumption data, and then discusses some of the tools that could be used for the multi-dimensional analysis of all dimensions of economic well-being.

Introduction

The analysis of household economic well-being can be enhanced significantly if the three dimensions of income, consumption and wealth are studied together. Previous chapters have provided a coherent and consistent framework for collecting and compiling the statistics required for such studies.

Life cycle perspectives

Consumption possibilities and requirements vary along the life cycle of individuals. Levels of income vary over a person's life cycle due to two main factors. People's labour force participation and earning capacity generally increases with age, peaking at middle age, and declining rapidly in older ages leading to retirement. For women, the earnings progression until middle age is generally lower than for men, on average, as younger women are more likely to work part-time or to take breaks from employment due to family reasons. The number of income earners in a household often varies over different life cycle stages. Couples with children will generally have lower incomes than couples without children, reflecting the lower number of employed persons in these households and the larger average number of persons in these households over which incomes are shared.

The distribution of wealth over the life cycle reflects a common pattern of wealth being accumulated throughout the working life and then being used during retirement. The distribution of wealth may also reflect cohort effects, with older cohorts in some institutional environments having lower opportunities for capital accumulation in earlier decades, for example, because women had, on average, lower participation rates in the paid workforce at that time and therefore lower balances in retirement saving schemes.

While levels of consumption also vary across the life cycle, individuals will tend to some extent to smooth their consumption over their lifetimes. Younger people may borrow from the future to support higher expenditure needs associated with making major purchases such as buying a home or starting a family. In the middle years, household consumption needs may level off, and higher incomes may be used to pay off borrowings and to save for retirement. Upon retirement, income levels and consumption needs may decline and households may dissave to support their consumption.

These life cycle effects on the level and distribution of household income, consumption and wealth need to be considered in any analysis of economic well-being. Life cycle effects will have implications for point-in-time comparisons and for longitudinal analyses. Cohort analysis over time may also reflect changes in the institutional environment, demographic factors and a range of other socio-economic characteristics and circumstances.

Equivalence scales

Distributional analyses of economic well-being rely on being able to account for differences in household size and composition when comparing those who are relatively well-off with those who are less well-off. The needs of a household grow with each additional member but, due to economies of scale in consumption, not in a proportional way. For example, a household comprising three people would normally need to consume more than a lone-person household if the two households are to enjoy the same standard of living. However, a household with three members is unlikely to need three times the housing space, electricity, etc., that a single-person household requires.

One way of adjusting for this difference in household size might be simply to divide income, consumption and wealth measures for the household by the number of its members, so that all the measures are presented on a per-capita basis. However, this assumes that all individuals have the same resource needs, and that there are no economies of scale derived from living together.

Various calibrations, or equivalence scales, have been devised to adjust the incomes of households in a way that recognises differences in the needs of individuals and the economies that flow from sharing resources. Equivalence scales have been developed primarily to adjust income estimates, because income is the most commonly used indicator of economic well-being. The next subsection discusses the use of equivalence scales in the context of income estimates, with later subsections extending the discussion to consumption, wealth and multi-dimensional measures.

Equivalence scales for income estimates

Equivalence scales differ in their details and complexity, but commonly recognise that the extra resources required by larger groups of people living together are not directly proportional to the number of people in the group. They also typically presume that children have fewer needs than adults.¹

When household income is adjusted according to an equivalence scale, the equivalised income can be viewed as an indicator of the economic resources available to a standardised household. When using a lone-person household as the reference point, its equivalised income is equal to the actual income recorded. For a household comprising more than one person, equivalised income is an indicator of the household income that would be needed by a lone-person household to enjoy the same economic well-being as the household in question.

Alternatively, equivalised household income can be viewed as an indicator of the standardised economic resources available to each individual in a household, where the standardisation reflects the economies of scale relevant to the household. The latter view underpins the calculation of income distribution measures based on the number of people, rather than the number of households.

Choice of equivalence scale

While there has been considerable research by statistical and other agencies to estimate appropriate values for equivalence scales, no single standard has emerged. In theory, many factors might be taken into account when devising equivalence scales. For example, people in the labour force are likely to face transport and other costs that affect their standard of living. It might also be desirable to reflect the different needs of children

at different ages, and the different costs faced by people living in different areas. On the other hand, the tastes and preferences of people vary widely, resulting in different expenditure patterns between households with similar income levels and composition.

Furthermore, it is likely that equivalence scales that appropriately adjust the incomes of low-income households are not as appropriate for high-income households, and vice versa. This is because the proportion of income spent on housing tends to fall as incomes rise, and cheaper per-capita housing is a major source of the economies of scale that flow from living together.

Similarly, it is likely that the equivalence scales that best correct disposable income are not as appropriate for different definitions of income. This is because the economies of scale achieved by households comprising more than one person can be considered as a proportion of the actual final consumption of the household. That proportion is the most relevant to adjusted disposable income but is less appropriate to other income concepts. For example, market income and total income are linked to consumption in a more indirect way than is adjusted disposable income.

Choosing a specific equivalence scale is hence fraught with difficulties. In many countries, for example, the elderly live in households that are relatively smaller, while children live in larger households. As a result, using an equivalence scale that assumes overly large economies of scale in consumption would understate child poverty and overstate poverty among the elderly.

It is difficult to define, estimate and use equivalence scales that take all relevant factors into account. As a result, analysts tend to use simple equivalence scales which are chosen subjectively, but which are consistent with the quantitative research that has been undertaken. A major advantage of simpler scales is that they are more transparent to users, making it easier to evaluate the assumptions being made for the equivalising process.

By using equivalence scales, each household type in the population is assigned a value in proportion to its needs. The factors most commonly taken into account to assign these values are the size of the household and the age of its members (whether they are adults or children). A wide range of equivalence scales exist, many of which are reviewed in Buhmann et al. (1998). Among OECD countries, the following scales have been used most commonly.

- *OECD equivalence scale.* This assigns a value of 1 to the first household member, of 0.7 to each additional adult and of 0.5 to each child. This scale (also called the “Oxford scale”) was mentioned by the OECD (1982) for possible use in countries that have not established their own equivalence scale. This scale is sometimes called the “old OECD scale”.
- *OECD-modified scale.* After having used the “old OECD scale” in the 80s and the earlier 90s, in the late 90s Eurostat adopted the so-called “OECD-modified equivalence scale”. This scale, first proposed by Haagenars et al. (1994), assigns a value of 1 to the household head, of 0.5 to each additional adult member, and of 0.3 to each child.
- *Square root scale.* Recent OECD publications (e.g. OECD, 2009) that compare income inequality and poverty across countries use a scale which divides household income by the square root of household size. This implies that, for instance, the needs of a household of four persons are twice as great as those of a single-person household. There is no differentiation between adults and children.

Table 8.1 illustrates how needs are assumed to change as household size increases, for the three equivalence scales described above, and for the two “extreme” cases of no sharing of resources within a household (per capita income) and full sharing (household income). In general, no specific equivalence scale is recommended by the ICW Framework for general use.

Table 8.1. Comparison of three commonly used equivalence scales

Household size	<i>Equivalence scale</i>				
	Per-capita income (no sharing)	OECD equivalence scale	OECD-modified scale	Square root scale	Household income (full sharing)
1 adult	1.0	1.0	1.0	1.0	1.0
2 adults	2.0	1.7	1.5	1.4	1.0
2 adults, 1 child	3.0	2.2	1.8	1.7	1.0
2 adults, 2 children	4.0	2.7	2.1	2.0	1.0
2 adults, 3 children	5.0	3.2	2.4	2.2	1.0
5 adults	5.0	3.8	3.0	2.2	1.0

Units on which to base equivalence scales

Equivalence scales are normally derived on the basis of the number of people in a household. However, the greatest economies of scale that are achieved by a group of people living together result from sharing a dwelling. Therefore, if a dwelling contains more than one household, it is better to derive the equivalence factor on the basis of the number of people in the dwelling, and then applying that factor to the income of each household living in the dwelling. This may have a significant impact on summary measures of income distribution if there are many households that share dwellings.

If analysis is undertaken using statistical units smaller than a household, such as a family economic unit, it is essential that any equalisation of income data undertaken uses at least the number of people in the household, if not the dwelling.

Derivation of equivalised household income

Equivalised household income, whether total, disposable or adjusted disposable income, is derived by calculating an equivalence factor according to the chosen equivalence scale, and then dividing income by the factor. Equivalised household income is an indicator of the economic resources available to each member of a household. It can therefore be used for comparing the situation of individuals as well as of households.

When income before equalisation is negative, such as when the losses incurred in a household’s unincorporated business or in other investments are greater than any positive income from any other sources, a common practice for empirical application is to set the negative values of equivalised income to zero.

Means and medians can be applied to both total household income and equivalised disposable household income to allow users to see the differences between data as collected and data as standardised to facilitate income distribution analysis. Table 8.2 illustrates the differences in income measures calculated from Australian 2007-08 data at different stages in the progression from total, or gross, household income to person-weighted equivalised disposable household income. The first column shows measures

calculated from gross household income, the second column shows estimates of income taxes paid on gross income, while the third column gives the resultant disposable household income.

While individuals with higher incomes would be expected to pay higher income tax than individuals with lower incomes, Table 8.1 shows that, in Australia, this relationship is not as strong for households. A household with a relatively high income may comprise only one individual with high income or it may include a number of individuals with relatively low income. Because of higher income taxes, the disposable income of the first household will be lower than that of the second, and will result in a re-ranking of households when considering percentiles. Therefore, a household may fall into a different percentile in an analysis of disposable income compared to an analysis of gross income.

Table 8.2 also shows that differences between disposable income and gross income increase as income levels increase. At the upper boundary of the tenth percentile (P10), the income tax to be paid by households with the lowest gross income is negligible. In contrast, the difference between the P90 value for gross household income and the P90 value for disposable household income at that same point is USD 655 per week.

Table 8.2. **Changes in income when moving from gross income to person-weighted equivalised disposable income, Australia, 2007-08**

		Gross household income per week	Income tax per week	Disposable household income per week	Equivalised disposable household income per week ¹	
					Household weighted	Person weighted
Percentile boundaries and percentile ratios						
P10	AUD	324	na	325	286	317
P20	AUD	540	na	539	365	410
P50	AUD	1 285	na	1 128	674	692
P80	AUD	2 390	na	1 962	1 091	1 079
P90	AUD	3 192	na	2 537	1 381	1 360
P90/P10	ratio	9.86	na	7.81	4.83	4.30
P80/P20	ratio	4.42	na	3.64	2.99	2.63
Means						
All households	AUD	1 649	284	1 366	803	811
One family households						
Couple family with dependent children	AUD	2 296	427	1 868	831	810
One parent family with dependent children	AUD	1 021	97	923	535	520
Couple only	AUD	1 626	285	1 341	896	896
Other one family households	AUD	2 157	336	1 820	902	916
Multiple family households	AUD	2 523	380	2 144	755	751
Non-family households						
Lone person	AUD	806	134	672	673	673
Group households	AUD	2 053	371	1 682	997	993

1. Equivalised using the OECD-modified scale.

Source: ABS Survey of Income and Housing (ABS, 2009).

In Table 8.2, disposable income relates to the household as a whole, and the percentiles and means are calculated with respect to the numbers of households concerned; these are referred to as household-weighted estimates. Equivalised disposable household income can also be household-weighted (fourth column in Table 8.2), but since it can be viewed as a measure of the economic resources available to each individual in a household, income measures for equivalised estimates are generally based on numbers of people rather than numbers of households (fifth column). This is referred to as person-weighting, and ensures that people in large households are given as much weight in the distribution as people in small households.

While the ranking underlying the formation of percentiles is the same for the household-weighted and person-weighted estimates, the boundaries between the percentiles differ, because household-weighted percentile boundaries create subgroups with equal numbers of households, while person-weighted percentile boundaries create subgroups with equal numbers of persons. The extent to which the boundaries differ reflects the extent to which the average household size differs between percentiles. For example, the person-weighted estimate of P10 (USD 317) is higher than the household-weighted estimate of P10 (USD 286). This implies that households with the lowest rankings of equivalised disposable household income tend to have a lower-than-average number of persons. In other words, the 10% of people with the lowest income comprise more than 10% of households.

For one-person households, the two measures of equivalised disposable income are the same (USD 673) and are just a little higher than disposable income (USD 672). Equivalised disposable income for lone-person households is approximately the same as disposable income, because the equivalising factor for such households is 1.0.²

For all other household compositions, equivalised disposable income is lower than disposable income, since income is adjusted to reflect household size and composition. Mean equivalised disposable income for couple households is the same for both the household-weighted and the person-weighted measures, since there are only two persons in such households. For most other multi-person households, person-weighted mean income is lower than the household-weighted mean. This implies that, within each type, larger households tend to have lower equivalised disposable household income, at least for the equivalence scale selected here.

Equivalence scales for consumption estimates

Equivalence scales have been developed to adjust household income to reflect the economies of scale achieved in consumption by households comprising more than one person, and empirical studies designed to derive appropriate equivalence scales have generally examined consumption data. Therefore equivalence scales used for income measures are equally applicable and relevant for consumption measures.

All the issues discussed above with respect to the derivation of equivalence scales for income are also relevant when applied to consumption measures; equivalence scales appropriate for poorer households may not be as appropriate for richer households; equivalence scales appropriate to one geographic region may not be as appropriate for another; equivalence scales appropriate for actual final consumption may not be as appropriate for consumption expenditure; and so on.

Equivalence scales for wealth estimates

Wealth is a stock of assets that is available to support consumption in the future, especially during retirement. When comparing households' wealth as an indicator of economic well-being in terms of potential future consumption, consideration needs to be given to which household members are likely to benefit from that wealth. Of particular interest are households containing children. The children are likely to leave the household before the wealth of the household is used to support household consumption during retirement. Therefore, for this type of analysis, it does not seem relevant to equivalise wealth on the basis of the economies of scale in current consumption experienced with the current household structure. Rather, analysis of wealth should focus on examining data classified by life cycle group. Such a focus is consistent with the expectation that wealth is often built up during a person's working life and then run down during retirement.

A different perspective can be taken when considering wealth as an economic resource that may be used to support current consumption. This is particularly important when analysing the situation of households at risk of economic hardship. Some households have very low income but are not at risk of economic hardship because they can draw on their wealth to support current consumption. In analysis of this kind, it is appropriate to equivalise wealth with the same equivalence scales used to standardise household income and consumption.

Multi-dimensional analysis of economic well-being

Multi-dimensional measures are necessary to get a comprehensive understanding of the economic well-being of individuals and households, as the notion of economic well-being (or material living standards) encompasses a number of dimensions (Stiglitz et al., 2009). A full appraisal of material living standards, as a pivotal element of the broader concept of human well-being, also requires a multi-dimensional approach. Indeed, and despite the fact that the material living standards of individuals are a joint function of income, consumption and wealth, income alone has been most often used in practice. This is clearly limiting, since it is quite possible for the income of a given individual to be small but for their wealth to be large (or vice versa). From a poverty perspective, headcounts of the income-poor could lead to the inclusion of many "false positives", e.g. people with income under the poverty threshold but with moderate or high wealth holdings, such as business owners whose current income may not be representative of their economic resources. Moreover, if a household has the expectation of higher income or of a significant windfall gain in the future, it may have higher current consumption than a household that has no such expectations. So while income and wealth determine the consumption possibilities of an individual household, low levels of income and wealth may not always imply a low level of consumption.

These examples, which illustrate the less-than-perfect correlation between the three dimensions of material living standards at the level of each person, point toward the need to develop multi-dimensional analysis to get a better understanding of material living conditions at the micro-level. This section presents different approaches to describing the joint distribution of household income, consumption and wealth.

Cross tabulations

While examining the distribution of household income, consumption and wealth separately offers a useful first approach, looking at the dependence between these three variables is the core of multivariate analysis. Cross tabulations can be used to describe the joint distribution of two or more variables, where continuous variables are categorised (e.g. quintiles of household income, household consumption and household wealth). Displaying a distribution of cases by their values on two or more variables is known as contingency tables. Whereas a frequency distribution provides the distribution of one variable, with one cell per category, each cell of a contingency table shows the number of households that provided a specific combination of responses (e.g. the number of households that fell into both the lowest quintile of income and the lowest quintile of wealth, or those that fell into the lowest quintile of income but into the fourth-highest quintile of wealth).

Table 8.3 provides an illustration of such cross tabulations, drawn from an Australian survey comprising household income and wealth data. Given that the main purpose of such analyses is to identify those most at risk of economic hardship, households in this analysis have been equivalised to standardise for differences in household size and composition, i.e. equivalised, and then weighted by person-weights so that the numbers of people are identified, rather than the number of households. The table shows that in 2009-10, only about one in three people in the lowest quintile of equivalised disposable household income were also in the lowest quintile of equivalised net worth, with nearly one half of them being in the third net worth quintile or higher.

Table 8.3. Example of income and wealth cross tabulations for Australia, 2009-10
Persons, net worth quintiles by equivalised disposable income quintiles

	Household net worth quintile					All persons
	Lowest	Second	Third	Fourth	Highest	
Disposable household income quintile	Number of persons ('000)					
Lowest	1 525.5	741.4	919.7	662.3	470.3	4 319.2
Second	1 070.9	896.0	926.5	823.5	603.1	4 320.0
Third	676.2	923.0	998.6	1 015.4	704.1	4 317.3
Fourth	473.8	932.0	828.4	1 076.7	1 005.2	4 316.1
Highest	229.1	734.9	571.8	874.8	1 906.3	4 316.9
All persons	3 975.5	4 227.3	4 245.0	4 452.6	4 689.0	21 589.4
	Proportion of persons (%)					
Lowest	35.3	17.2	21.3	15.3	10.9	100.0
Second	24.8	20.7	21.4	19.1	14.0	100.0
Third	15.7	21.4	23.1	23.5	16.3	100.0
Fourth	11.0	21.6	19.2	24.9	23.3	100.0
Highest	5.3	17.0	13.2	20.3	44.2	100.0
All persons	18.4	19.6	19.7	20.6	21.7	100.0

Source: ABS Survey of Income and Housing (ABS, 2009-10).

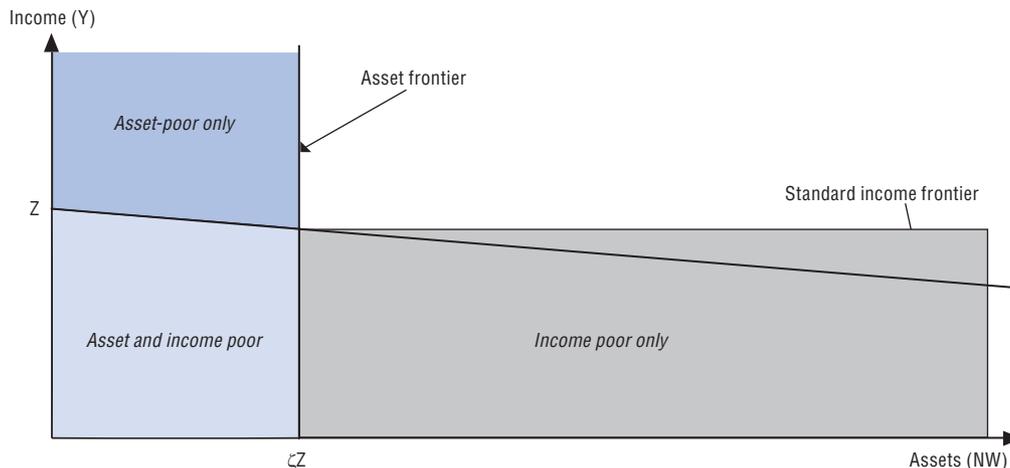
Income and wealth: Combining stock and flow variables

Household income and consumption are flows observed over a period of time, while net worth is a stock variable observed at a point in time. This difference makes their integration difficult. Despite this difficulty, income and wealth are the most important determinants of the economic opportunities of each household, i.e. the goods and services

over which they have command, while consumption expenditure translates into the realisation of this consumption opportunity. From this perspective, if income and wealth could be made commensurable and integrated into a single scalar value for each household, it would then be possible to derive distributional measures based on the distribution of this new variable.

One way to achieve such integration relies on the concept of asset-based poverty, where asset poverty is defined as an individual having wealth-holdings insufficient to meet their basic needs over a specified amount of time. Figure 8.1 illustrates this concept and its relationship to income poverty. In this figure, Y represents an individual's income and NW represents an individual's net worth. In this space, Z represents the income poverty line, while the asset poverty line (ζZ) corresponds to the income poverty line multiplied by a fraction ζ equal to the length of the reference period (in this case three months, which is equal to one-quarter of the income poverty line). An individual is counted as asset-poor if $NW < \zeta Z$; whilst income poverty occurs if $Y < Z$.

Figure 8.1. **Asset and income-based poverty measures**



Source: Brandolini et al., 2010.

Taking wealth into consideration allows distinguishing, among the income-poor, those who have sufficient wealth to keep them at the poverty line for a period of at least $\zeta \times 12$ months (the “income-poor only”) from those who lack this buffer (the “asset and income poor”, shown by the grey area). Both groups experience low income, but the latter are clearly worse-off than the former. A third group comprises the “asset-poor only”, i.e. people who currently have sufficient income to achieve the minimally acceptable standard of living but do not have enough assets to protect them from a sudden drop of their income.

This approach can be extended when wealth at a point in time is smoothed over time, usually over a person's life expectancy (expressed in years). In this case, net worth is converted into an annuity as suggested by Weisbrod and Hansen (1968). In this perspective, a “wealth-enlarged income concept” I_t^* in period t can be defined as:

$$I_t^* = I_t + W_t A_n$$

In this formulation, I_t^* is defined as the sum of the current income of each unit I_t and the lifetime annuity of their current net worth $W_t A_n$, where $A_n = \frac{r}{1 - (1+r)^{-n}}$ is the value of an annuity available over n years for an interest rate of r . For a given interest rate, the greater the net worth of a person and the shorter their life expectancy, the greater the annuity will be, and therefore the difference between the person's current income and their wealth-enlarged income. This suggests that the distribution of economic opportunities will differ significantly depending on whether income or wealth-enlarged income is used.

The wealth-enlarged income concept provides a consistent way of combining wealth and income into a single continuous variable on the basis of which univariate analysis techniques can be subsequently applied. Table 8.4 shows how this combination can enrich the analysis of economic hardship in comparison to an income-based approach. Indeed, for countries present in the Luxembourg Wealth Study, headcount poverty measures based on wealth-enlarged income are significantly lower than those based on income alone.

Table 8.4. Poverty rates of the income-poor and the wealth-enlarged income poor for selected countries of the Luxembourg Wealth Study

Country	National lines			US-PSID line		
	Income and net worth poor	Income poor	Difference	Income and net worth poor	Income poor	Difference
Net Worth						
Annuity interest rate: 2%						
Finland (1998)	8.4	10.6	-2.2	30.8	39.8	-9.0
Germany (2002)	11.3	12.9	-1.6	25.8	30.6	-4.8
Italy (2002)	9.2	12.5	-3.3	29.8	42.3	-12.5
US-PSID (2001)	14.5	17.4	-2.9	14.5	17.4	-2.9
US-SCF (2001)	16.6	19.5	-2.9	23.7	27.5	-3.8
Annuity interest rate: 10%						
Finland (1998)	8.4	10.6	-2.2	28.5	39.8	-11.3
Germany (2002)	11.2	12.9	-1.7	24.9	30.6	-5.7
Italy (2002)	8.9	12.5	-3.6	27.8	42.3	-14.5
US-PSID (2001)	14.5	17.4	-2.9	14.5	17.4	-2.9
US-SCF (2001)	15.9	19.5	-3.6	22.9	27.5	-4.6
Total financial assets						
Annuity interest rate: 2%						
Finland (1998)	10.2	10.6	-0.4	39.6	39.8	-0.2
Germany (2002)	13.4	12.9	0.5	30.5	30.6	-0.1
Italy (2002)	12.3	12.5	-0.2	40.5	42.3	-1.8
US-PSID (2001)	16.3	17.4	-1.1	16.3	17.4	-1.1
US-SCF (2001)	19.0	19.5	-0.5	26.6	27.5	-0.9
Annuity interest rate: 10%						
Finland (1998)	10.0	10.6	-0.6	38.6	39.8	-1.2
Germany (2002)	13.1	12.9	0.2	29.6	30.6	-1.0
Italy (2002)	12.1	12.5	-0.4	39.7	42.3	-2.6
US-PSID (2001)	16.3	17.4	-1.1	16.3	17.4	-1.1
US-SCF (2001)	18.5	19.5	-1.0	26.2	27.5	-1.3

Source: Brandolini et al., 2010.

The poverty headcounts based on wealth-enlarged income depend on a variety of choices and assumptions made in deriving a measure of wealth-enlarged income, all of which impact on the final outcome.

- *Base income.* The income elements to be used as base income need to be established. Base income is the income that would be available in the absence of any wealth, and to which annuitised wealth is then added. Ideally, base income would normally equal adjusted disposable income minus property income. Adjusted disposable income is the starting value, because it is normally the best income-proxy of material well-being. Property income, such as interest, dividends and rent, is excluded to avoid double-counting when the value of that property is annuitised and added to the base income. However, while desirable, it would not normally be possible to exclude that part of self-employment income that is attributable to a return on capital invested in an own unincorporated business, since that component cannot be separated from the return to employment component, and the latter should be included in base income.
- *Assets to be annuitised.* Concerning the specification of net worth to be annuitised (W_t in the formula above), some researchers include only the elements that can be converted to cash and spent on current consumption without the sale of the assets concerned impacting negatively on consumption (Wolff, Zacharias and Caner, 2005). They therefore exclude the value of owner-occupied housing and consumer durables because those assets provide services consumed by the household. If the dwelling were sold, housing would have to be rented in the market, and the same applies for the services provided by consumer durables. Benefits from defined-benefit private pension schemes are also excluded by some analysts because they cannot be sold. If some assets are omitted from W_t , the income derived from them, such as the imputed rent from owner-occupied housing, should in turn be included in it. Alternatively, it might be considered that the sale of assets is only notional, and that a more appropriate result for some purposes is to include all assets in the value to be annuitised.
- *Interest rate to be applied.* A single interest rate such as a historic long-term discounted bond rate can be used when annuitising a household's net worth (r in the formula above). The rate could be expressed in real terms, thereby adjusting for the influence of inflation on the bond rate, and net of the income tax that would be levied on the annuitised income stream. Alternatively, different rates could be used for different asset types to reflect the differences in wealth composition. Should the latter approach be considered, then the rate of return for owner-occupied housing could be based on imputed rents. However, care would need to be taken that real holding gains and losses are properly reflected in the rates of return used. Imputed rents do not reflect holding gains and losses.
- *Length of annuity.* The length of the annuity is normally specified as the life expectancy of the household reference person or, if relevant, the spouse of the household reference person, if younger.
- *Inter-generational wealth transfers.* The formula given above assumes that no wealth transfer occurs between generations, i.e. none of the wealth of the household remains at the end of the period. This does not imply that no wealth transfer between generations will occur in reality, as the measure proposed is a notional concept developed to better indicate economic resources currently available to a household. For some analyses, the

formula could be amended to assume that some wealth does remain at the end of the annuity period.

- *Changing household composition.* The above formula does not take account of the changing composition of households over time and that a greater amount of wealth will be needed to support a constant standard of living when there are more persons in the household. This issue can be addressed by using a more complex formula that introduces mortality rates and an equivalence scale and makes assumptions about when children will leave the family home.
- *Equivalisation.* Wealth-enlarged income is a measure designed to give an indication of consumption using current income and a share of current wealth in a way that would be sustainable for the life expectancies of the household reference person and, where relevant, their spouse. It is therefore appropriate to use the same equivalence scale on this measure as is used for income before the wealth adjustment.

Income and consumption: An analysis of redistribution

The availability of coherent and consistent income and consumption data can also support more integrated analyses of the redistribution that occurs as part of government tax and transfer systems. Government programs can have a direct impact on the economic well-being of households; social benefits provide resources to households, while taxation removes resources from them. It is therefore of interest to analyse the redistributive impact of the various elements of the governmental tax-transfer system, including production taxes that impact on the costs of the goods and services purchased by households.

The starting point of such an analysis is to estimate net private income, the disposable income households would have had available without the payment of social benefits from the government and without paying current transfers to the government. In terms of the ICW Framework elements presented in Annex A, this is equal to:

- disposable income (element ID) less,
- pensions and other cash benefits from social security (I4.1) less,
- social assistance benefits in cash from government (I4.3) plus,
- direct taxes, net of refunds (E2.1) plus,
- compulsory fees and fines (E2.2) plus,
- employee and employers' social contributions to social security schemes (the social security component of E2.3).

The redistributive impact of cash benefits can be analysed by examining the distribution across households of the cash benefits received from social security and social assistance and comparing this with the distribution across households of net private income. The redistributive impact of social transfers in kind (STIK) received from government can be analysed in a similar way.³

While social benefits add to the income received by households, direct taxes and similar direct transfers to government subtract from the income available to households to spend or save. Those transfers also have a redistributive impact, and the distribution of direct taxes, compulsory fees and fines, and employee and employers' social contributions to social security schemes can be compared to the distribution of net private income in the same way as in the case of cash benefits and STIK received from government.

Note that there should be consistency in the definition of social security schemes with regard to: i) pensions and other cash benefits from social security; ii) employee and employer social contributions to social security schemes that are part of current transfers paid; and iii) employer social contributions to social security schemes that are part of income from employment, and therefore of net private income. The net impact of receiving cash benefits from government and paying current transfers to government can be examined by comparing net private income and disposable income. The additional impact of receiving STIK can be examined by including adjusted disposable income in the comparison.

This analysis can be extended to examine the redistributive effect of indirect taxes, or taxes on production (including imports). The analysis needs to use concepts and measures not included in the ICW Framework. Taxes on production are usually levied on the producers and suppliers of goods and services, and therefore the payment of the taxes is not normally a household transaction.⁴ Rather, the prices paid by households for goods and services reflect the taxes on production that are paid by others. However, since taxes on production are often seen as a regressive form of taxation, it is of interest to estimate what proportion of a household's consumption expenditure reflects taxes on production that have been paid in conjunction with the production of those goods and services.

The distribution of taxes on production ultimately paid by households can be analysed by the type of tax, such as value-added tax, taxes on alcohol and tobacco, import duties, regular taxes on capital, and so on. Such analysis is of interest because taxes on production can be levied for other reasons than raising revenues, including disincentives to consume imports or products such as tobacco. In evaluating whether the taxes are contributing to their primary objectives, any redistributive impact of the individual taxes should be considered.

Estimates of the value of the taxes on production ultimately borne by households can be subtracted from adjusted disposable income to give final income. Comparing final income with adjusted disposable income gives an indication of the redistributive impact of taxes on production. Comparing final income with net private income gives an indication of the net redistributive impact of all government benefits and taxes combined. Both of these comparisons require the joint analysis of income and consumption.

Although compilations of indirect taxes are difficult, there are several ways to accomplish this task. Statistics Denmark has developed a method where the taxes on production are compiled in an integrated framework with the Household Budget Survey (HBS). Estimates are produced yearly and combine micro consumption data from the HBS with the tax legislation used in the compilation of the Danish net price index.

Statistics Denmark has produced comparable estimates of the indirect taxes paid by private households for the period 1994 to 2009 as an integrated part of the HBS compilation. Figure 8.2 shows the impact of indirect taxes and social transfers in kind (STIK) on household disposable income. The figure highlights that the positive effect of STIK on adjusted disposable income is fully offset by that of indirect taxes over the period considered.

Figure 8.3 shows a decomposition of the indirect taxes by type and by household income bracket. Value-added tax has the highest impact, followed by excise duties, while stamp duties have only a marginal effect. Households with the highest incomes pay the

Figure 8.2. Household adjusted disposable income, Denmark in 1994-2009

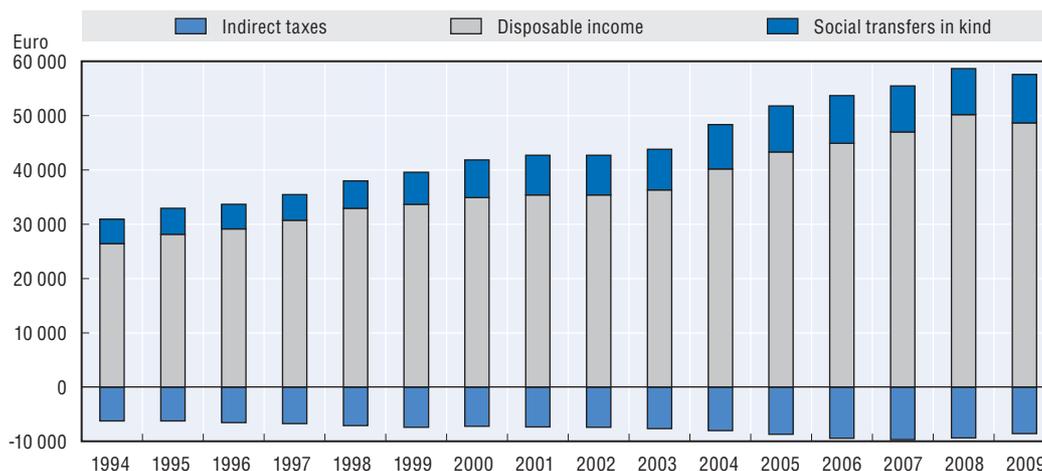
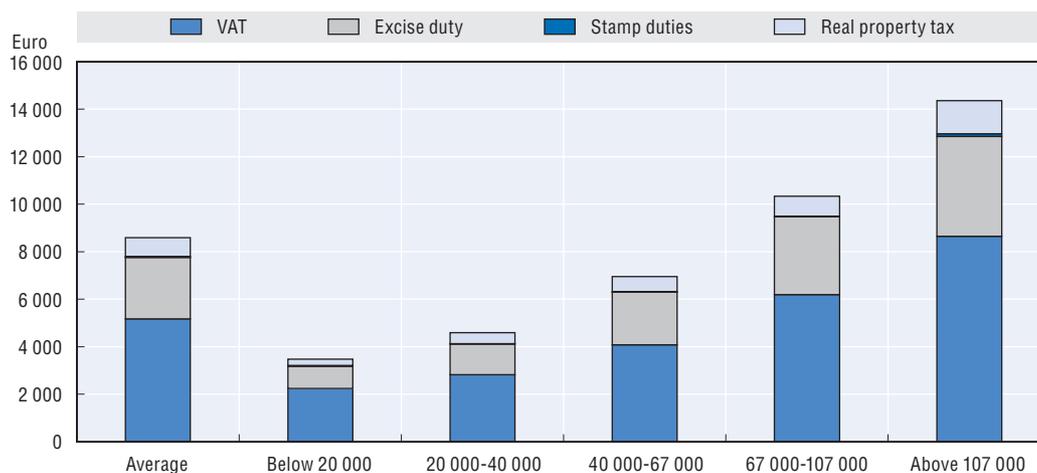


Figure 8.3. Decomposition of indirect taxes by type and level of household income, Denmark in 2009



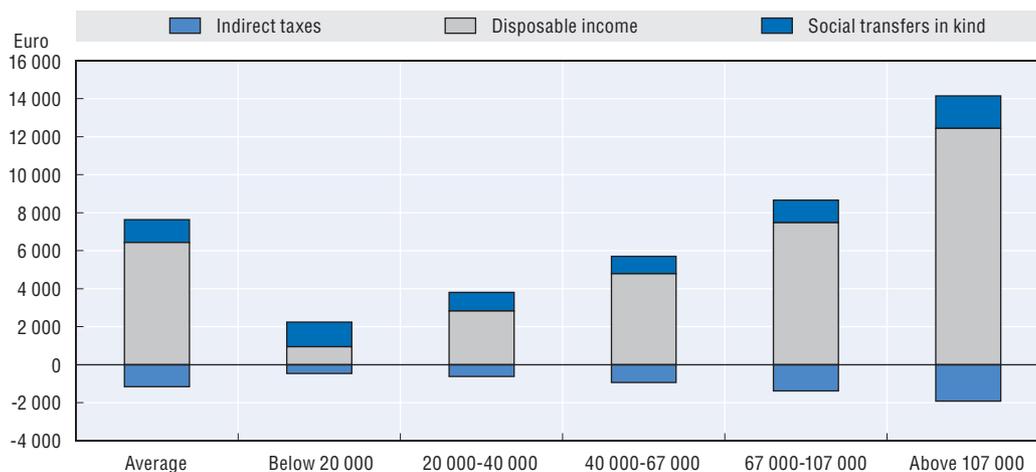
highest amount of indirect taxes, due to the high positive correlation between income and consumption.

Finally, Figure 8.4 shows the impact of indirect taxes and social transfers in kind (STIK) on disposable income, across different income ranges. While the effect of indirect taxes seems to be broadly proportional to the level of income, the impact of STIK is much flatter. The total effect on final income (disposable income plus STIK, less indirect taxes) compared to disposable income is clear: final income rises for the lowest income groups, while it declines marginally for the highest income groups.

Composite multi-dimensional measures

The techniques presented below are based on multivariate generalisations of the procedures used to construct summary measures of the level and dispersion of a single economic measure (UNECE, 2011). As multi-dimensional measurement is a new field of statistics, some of the conventional tools used to summarise distributions such as Lorenz

Figure 8.4. **Impact of indirect taxes and STIK on household disposable income broken down by household total income, Denmark in 2009**



curves or Gini coefficients are not yet fully defined and developed in this area. Three measures are discussed below:

- *Multi-dimensional counting*, characterising the position of each household in the joint distribution of income, consumption and wealth by the definition of appropriate thresholds.
- *Multi-dimensional measure of central tendency*, mapping the characteristics of the distribution of the three variables into a single index conveying information on the average achievements of each unit.
- *Multi-dimensional measure combining central tendency (i.e. mean achievements) and dispersion (i.e. inequality) in a single summary statistic.*

The three multi-dimensional measures lead to single summary statistics of the economic well-being of each person. They will be illustrated by considering income, consumption and wealth simultaneously in order to depict the general measurement framework under consideration. At the outset, it should be stressed that micro data on household income, consumption and wealth do not serve the same objective. Income measures people's command over current resources, wealth is a measure of command over future resources, while consumption expenditure is an achievement in itself. In this sense, the three variables do not affect individual well-being in the same way. It follows that consideration solely of household income and wealth may be considered as providing a full characterisation of the consumption possibilities of each household, based on the economic resources currently available. But, alternatively, one could also argue that the consumption expenditure of each unit should be measured jointly with its income and wealth in order to get information on how consumption possibilities are converted into the goods and services actually consumed, and what is the true material well-being of the household considered. Apparent inconsistencies between the available resources and the goods and services consumed may reflect factors not measured, such as expectations about resources to become available in the future, or they may reflect errors or timing differences in some of the data being used. The matrix-based measures can be used to analyse the data from various perspectives: while the implicit assumption made when constructing summary measures in the three-dimensional space is that household

income, consumption and wealth are weighted equally, one could also easily “exclude” consumption expenditure by assigning it a weight of zero and then reducing the analysis to income and wealth only. The multi-dimensional measures presented in this section have the same properties and characteristics in both cases.

Multi-dimensional counting

In one-dimensional analysis, counting is usually accomplished by the use of thresholds (as for example in poverty analysis), with individuals or households being identified as those whose achievements fall above or below the threshold. In a multi-dimensional setting, counting is a more complex exercise, as several parameters need to be specified before computation:

- First, a vector of thresholds $z = (z_I, z_C, z_W)$, where each variable denotes the threshold used for income, consumption and wealth, and which are used to determine the position of each unit with respect to each dimension.
- Second, a vector of weights $w = (w_I, w_C, w_W)$, used to indicate the relative importance of income, consumption and wealth.
- Third, counting vectors $c = (c_1, \dots, c_n)$, whose entries indicate whether the achievements of each unit of observation are above (indicated by a value of one) or below (indicated by a value of zero) the threshold selected, for each of the dimensions considered.
- Fourth, a general threshold k (with $0 < k \leq 3$) used to determine the position of the household in the multivariate distribution. This general threshold is necessary, as an individual has to be doubly located in multivariate analysis: first inside each dimension, then across dimensions.
- Finally, an aggregation function, which will summarise the outcome of the above process over the entire population.

Multi-dimensional counting is most easily understood by examining a sequence of matrices. Let X be a matrix where each column denotes respectively the income, consumption and wealth over 5 individuals (displayed in rows):

$$X = \begin{pmatrix} 3 & 1 & 2 \\ 6 & 2 & 5 \\ \underline{7} & 3 & 10 \\ \underline{7} & \underline{5} & \underline{14} \\ \underline{10} & \underline{5} & \underline{24} \end{pmatrix}$$

First assume that one is interested in identifying all the individuals whose achievements are above certain thresholds $z = (6, 3, 10)$. In this case, achievements above those thresholds are indicated by the underlined terms in X . A counting matrix X^0 then replaces each entry in the matrix X with values of 1, for units falling above the threshold considered, and of 0, for units falling below it:

$$X^0 = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

The aggregation step uses X^o and the general threshold k to generate the multi-dimensional counting. For a general threshold equal to $k = 2$, individuals are considered as having adequate economic resources if at least two of their entries in terms of income, consumption and wealth are above the specific thresholds considered, which is indicated by a value of 1 in the matrix X^o . In this example, only the last two individuals fill this condition, while individual 3 has only income above the specific threshold. This achievement is then disregarded in X^o , which gives a censored counting matrix:

$$X^o(k \geq 2) = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

Finally, the multi-dimensional counting is computed as the mean of the terms that appear in the censored deprivation matrix. In our example, the sum of the positive entries is 6, while the total number of entries is 15, resulting in a count of 2/5. This value has to be interpreted as the actual number of achievements above the dimension-specific thresholds z among individuals located above the general threshold k . This measure is the natural generalisation of univariate counting, combining counting inside each of the three dimensions as well as counting across the three dimensions, the former being a by-product of multi-dimensional analysis. In practice, multi-dimensional counting is easy to operationalise, and can provide considerable detail on the features of a multivariate distribution when computed for different threshold's specifications.

Multi-dimensional measure of central tendency

The multi-dimensional counting described in the previous section is an aggregation procedure that conveys information on the distribution of achievements across units according to specific thresholds. An alternative approach is provided by measures of central tendency, which aim to summarise information on all the entries of a multivariate distribution. Despite some weaknesses, the arithmetic mean (the sum of all achievements in the matrix divided by the number of observations) remains the most frequently used measure of central tendency in univariate analysis. Its multi-dimensional counterpart can also be easily computed.

Computing a multi-dimensional mean first requires normalising the observed values of household income, consumption and wealth in order to make their scale comparable across dimensions; through such normalisation, each dimension is ratio-scaled, with the lowest value set as 0% achievement and the highest as 100%. In this way, the comparability across the three monetary variables is guaranteed: 50% of the highest achievement in one variable is the same as 50% of the others. For each dimension, this transformation requires taking each value and subtracting from it the lowest achievement assumed or observed in the associated dimension (considered in what follows as zero), and then dividing the result by the difference between the maximum achievement assumed or observed (considered in

what follows as the maximum observed in each of the distributions) and the minimum. Considering the example previously used, the normalised matrix X^N is thus:

$$X^N = \frac{\begin{pmatrix} 3-0 & 1-0 & 2-0 \\ 10-0 & 5-0 & 24-0 \\ 6-0 & 2-0 & 5-0 \\ 10-0 & 5-0 & 24-0 \\ 7-0 & 3-0 & 10-0 \\ 10-0 & 5-0 & 24-0 \\ 7-0 & 5-0 & 14-0 \\ 10-0 & 5-0 & 24-0 \\ 10-0 & 5-0 & 24-0 \\ 10-0 & 5-0 & 24-0 \end{pmatrix}}{\begin{pmatrix} 10 & 5 & 24 \\ 10 & 5 & 24 \\ 10 & 5 & 24 \\ 10 & 5 & 24 \\ 10 & 5 & 24 \\ 10 & 5 & 24 \\ 10 & 5 & 24 \\ 10 & 5 & 24 \\ 10 & 5 & 24 \\ 10 & 5 & 24 \end{pmatrix}} = \begin{pmatrix} 0.3 & 0.2 & 0.1 \\ 0.6 & 0.4 & 0.2 \\ 0.7 & 0.6 & 0.4 \\ 0.7 & 1 & 0.6 \\ 1 & 1 & 1 \end{pmatrix}$$

Based on this normalised matrix X^N , the multi-dimensional mean is then computed by aggregating all the terms of the normalised matrix, and then dividing the sum by the number of terms:

$$\begin{pmatrix} 0.3 & 0.2 & 0.1 \\ 0.6 & 0.4 & 0.2 \\ 0.7 & 0.6 & 0.4 \\ 0.7 & 1 & 0.6 \\ 1 & 1 & 1 \end{pmatrix} \rightarrow \begin{pmatrix} 0.2 \\ 0.4 \\ 0.6 \\ 0.8 \\ 1 \end{pmatrix} \rightarrow 0.6$$

This value represents the mean achieved level over all units and over all dimensions, expressed in the normalised scale unit. In practice, multi-dimensional means are easily computed and are the only way to provide a measure of central tendency for a multivariate distribution, as other conventional measures of central tendency such as the median cannot be defined in this case.

Multi-dimensional measure combining central tendency and dispersion

Multi-dimensional measures of central tendency can be adapted in order to reflect the dispersion of achievements within each of the dimensions considered. To do so, the normalised matrix should be transformed so that each of its terms is elevated to a power inferior to one, where this coefficient is an inequality aversion parameter that expresses the degree of penalisation that is imposed on more unequal distributions:

$$\begin{pmatrix} 0.3^\alpha & 0.2^\alpha & 0.1^\alpha \\ 0.6^\alpha & 0.4^\alpha & 0.2^\alpha \\ 0.7^\alpha & 0.6^\alpha & 0.4^\alpha \\ 0.7^\alpha & 1^\alpha & 0.6^\alpha \\ 1^\alpha & 1^\alpha & 1^\alpha \end{pmatrix}$$

Again, the multi-dimensional mean is computed based on this matrix, but at each stage of aggregation the inverse power transformation is applied to the mean. For example, for $\alpha = -2$, this gives:

$$\begin{pmatrix} 0.3^{-2} & 0.2^{-2} & 0.1^{-2} \\ 0.6^{-2} & 0.4^{-2} & 0.2^{-2} \\ 0.7^{-2} & 0.6^{-2} & 0.4^{-2} \\ 0.7^{-2} & 1^{-2} & 0.6^{-2} \\ 1^{-2} & 1^{-2} & 1^{-2} \end{pmatrix} \rightarrow \begin{pmatrix} \left[\frac{1}{3}(0.3^{-2} + 0.2^{-2} + 0.1^{-2}) \right]^{-\frac{1}{2}} \\ \left[\frac{1}{3}(0.6^{-2} + 0.4^{-2} + 0.2^{-2}) \right]^{-\frac{1}{2}} \\ \left[\frac{1}{3}(0.7^{-2} + 0.6^{-2} + 0.4^{-2}) \right]^{-\frac{1}{2}} \\ \left[\frac{1}{3}(0.7^{-2} + 1^{-2} + 0.6^{-2}) \right]^{-\frac{1}{2}} \\ \left[\frac{1}{3}(1^{-2} + 1^{-2} + 1^{-2}) \right]^{-\frac{1}{2}} \end{pmatrix}$$

$$\rightarrow \begin{pmatrix} 0.1 \\ 0.3 \\ 0.5 \\ 0.7 \\ 1 \end{pmatrix} \rightarrow \left[\frac{1}{5}(0.1^{-2} + 0.3^{-2} + 0.5^{-2} + 0.7^{-2} + 1^{-2}) \right]^{-\frac{1}{2}} = 0.3$$

In this example, the final value obtained is half the value of the multi-dimensional mean computed in the previous section. This difference from the average achievement is the result of discounting for two forms of inequality: first, the spread of each distribution (i.e. inter-individual inequality, as in the case of univariate analysis); and, second, inequality among dimensions for each individual (which is a specific by-product of multivariate analysis).

The inclusion of wealth and consumption in addition to income in a composite indicator leads to significant differences from an income-based approach. Table 8.5 illustrates how such inclusion leads to a consistently lower level of overall achievement in material conditions for each decile of disposable income, as well as to a systematic higher penalisation for inequality in comparison to the same measure applied to income only (i.e. when consumption and wealth are assigned zero weights in the framework above). Also, the penalisation due to inequalities when moving from consideration of income alone to consideration of the joint distribution of income, consumption and wealth increases as the inequality aversion parameter rises.

The summary measures shown in Table 8.5 embody information on both mean achievement and dispersion, and they are the multi-dimensional analogue of the Atkinson measures in the univariate case. A complementary index, which makes a bridge between the multi-dimensional measure of central tendency and the inequality-sensitive measure, can be computed as 1 minus the ratio between this inequality-sensitive measure and the multi-dimensional mean described in the previous section: the value obtained (0.5 in the numerical example used here) ranges between 0 and 1: the closer this index is to one, the more income, consumption and wealth achievements are dispersed, both between and within individuals.

Table 8.5. Multi-dimensional inequality-sensitive measures of households' material conditions per decile of disposable income, France in 1995

Deciles of disposable income	Income alone				Income, consumption and wealth			
	Aversion parameter				Aversion parameter			
	1	0	-1	-2	1	0	-1	-2
1	0.51	0.49	0.47	0.45	0.39	0.33	0.24	0.15
2	0.69	0.69	0.69	0.69	0.46	0.38	0.28	0.21
3	0.72	0.72	0.72	0.72	0.49	0.42	0.34	0.25
4	0.73	0.73	0.73	0.73	0.52	0.46	0.39	0.32
5	0.75	0.75	0.75	0.75	0.54	0.49	0.44	0.37
6	0.76	0.76	0.76	0.76	0.57	0.53	0.48	0.42
7	0.77	0.77	0.77	0.77	0.60	0.56	0.52	0.47
8	0.79	0.79	0.79	0.79	0.63	0.60	0.56	0.52
9	0.80	0.80	0.80	0.80	0.67	0.64	0.61	0.56
10	0.84	0.84	0.84	0.84	0.76	0.73	0.70	0.66
Total	0.74	0.73	0.72	0.70	0.56	0.50	0.41	0.29

Note: The computations are based on a 1995 joint survey of income, consumption and wealth for France.

Source: Ruiz, 2011.

Several assumptions are implicit in the construction of these inequality-sensitive multi-dimensional measures. First, the choice of an inequality aversion parameter is required for discounting for the two forms of inequality: the smaller the power transformation applied, the larger the penalisation (while for a power equal to one, one gets the measure with no penalisation). While this leaves room for arbitrary choices, it is the only measure available for appraising dispersion in multi-dimensional analysis, as no obvious generalisation of Lorenz curves and Gini index can be applied to two or three dimensions simultaneously. Second, the multi-dimensional framework requires considering a specific form of inequality (among dimensions for the same individual) that has a less intuitive interpretation than standard inequalities in the univariate setting. Inherent to multi-dimensional analysis, this dispersion captures the fact that, when the dispersion of entries in a multivariate distribution is driven more by one of its sub-dimension than by others, this imbalance has to be reflected in the measure of dispersion.

The summary statistics of multi-dimensional achievements described above extend the univariate concepts of mean and variance into a multi-dimensional space. Since the mean and variance of income and consumption variables would normally be equalised, it would also be appropriate to equalise wealth when computing these measures. First, bringing the three dimensions together is the focus of economic well-being. Second, it would be difficult to interpret a measure that includes equalised income and consumption but not equalised wealth.

Summary

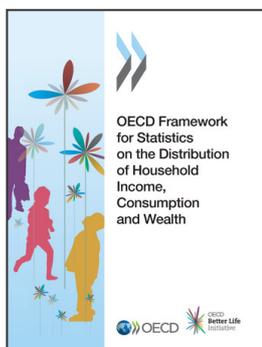
The key highlights from this chapter can be summarised as follows:

- Consumption possibilities and consumption requirements vary with the life cycle progression. An individual's labour force participation and earning capacity increases with age, peaking at middle age, and declining rapidly in older age leading to retirement. The distribution of wealth over the life cycle reflects the common pattern of wealth being gradually accumulated throughout the working lives of household members and then being utilised during retirement. Life cycle effects on income, consumption and wealth levels and distribution need to be considered in any analyses of economic well-being.

- Various equivalence scales have been devised to make adjustments to the actual incomes of households in a way that recognises differences in the needs of individuals and the economies that flow from sharing resources. Therefore, equivalence scales used for income measures are equally applicable and relevant for consumption measures. However, there is no accepted method for determining equivalence scales, and no specific equivalence scale is recommended by the ICW Framework for general use.
- Equivalence scales based on current household composition are not necessarily relevant when analysing wealth from the perspective of potential future consumption, since the household composition may change in the future. However, equivalence scales based on current household composition are relevant when analysing wealth from the perspective of current consumption, especially when analysing households currently at risk of economic hardship.
- Appropriate tools are needed to undertake the multi-dimensional analysis of income, consumption and wealth. Cross tabulations are a basic tool that can be used for this purpose.
- Income and wealth are both economic resources that can support consumption. However, combining them into a single indicator of economic resources is difficult, because income is a flow concept and wealth is a stock concept. One approach that can be taken is to derive estimates of wealth-enlarged income, in which the value of wealth is annuitised and added to the value of income.
- The availability of coherent and consistent income and consumption data together can support analyses of the redistribution that occurs as a result of government tax and transfer systems. This analysis becomes more comprehensive when the redistributive impact of indirect taxes (or taxes on production, including imports) is included. This aspect of the analysis needs to use concepts and measures not included elsewhere in the ICW Framework.
- Multi-dimensional measurement is a relatively new field of statistics, and popular tools such as Lorenz curves and Gini coefficients used to summarise single-dimensional distributions are not fully defined and developed in the area of multi-dimensional measurement. However, there are some single statistic summary measures of level and dispersion in multiple dimensions. These include: a count of individuals or households above or below a multi-dimensional threshold, for example, a definition of poverty; a multi-dimensional measure of central tendency analogous to the univariate mean; and a multi-dimensional measure combining central tendency and dispersion analogous to the Atkinson measures in the univariate case.

Notes

1. This subsection draws from Section 6.4 of the *2011 Canberra Group Handbook*.
2. The reason for the slight difference between them is that some households have negative disposable income and these values are set to zero for the calculation of equivalised income.
3. In principle, social transfers in kind received from non-profit organisations should be included with net private income when analysing redistribution.
4. Households are likely to pay certain types of taxes on production, but these are normally associated with the production or investment activities of the household, for example, rates paid for owned real estate.



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