The distributive impact of the Luxembourg tax-benefit system: a more comprehensive measurement

Vincent Vergnat[1,2]

Conchita D'Ambrosio[1]

Philippe Liégeois[2]

Accepted for publication in

Public Finance Review

[1] Université du Luxembourg

[2] Luxembourg Institute of Socio-Economic Research (LISER)

Corresponding Author:
Vincent Vergnat, Luxembourg Institute of Socio-Economic Research (LISER), 11 Porte des Sciences, 4366 Esch-sur-Alzette, Luxembourg
Email: vincentvergnat@gmail.com

Abstract

This article studies the distribution of income in Luxembourg by integrating two aspects that have been previously neglected: indirect taxation and in-kind transfers. The integration of the latter is essential in Luxembourg, the country with the highest public expenditure per capita in the OECD. These issues have been understudied because of some methodological challenges, including the lack of data containing all the necessary information for this type of analysis. However, with the EUROMOD microsimulation model, different data sources, and imputation methods, we are able to obtain a more complete view of the income distribution in Luxembourg. We find that, as in many developed countries, indirect taxes are regressive. On the other hand, in-kind transfers play an important role in reducing income inequality, in particular through education and health services.

Keywords: Income distribution, Inequality, In-kind transfers, Indirect taxation, Microsimulation

JEL classification: D31, I30, H20, H40

Introduction

The majority of income distribution studies only consider direct taxes and cash transfers. The measurement of income is thus limited to household disposable income, corresponding to the sum of primary income, replacement income, public cash social transfers, and private transfers between households net of social contributions and direct taxes. This definition does not allow for a comprehensive measurement of income, since it neglects two important aspects of tax-benefit systems: indirect taxation and in-kind transfers. The main reasons for this omission are, on the one hand, a lack of data on the consumption and use of public services in surveys devoted to the analysis of household income (for example, the European Union-Statistics on Income and Living Conditions/EU-SILC), and on the other hand, methodological difficulties arising from the measurement of well-being when in-kind transfers are to be considered.

As a result, most of the EU studies that involve the measurement of poverty and inequality look at household disposable income only, leading to an overestimation or underestimation of income inequality and poverty, and biased international comparisons. As Garfinkel, Rainwater, and Smeeding (2006) show, the inclusion of in-kind transfers and indirect taxes among rich countries significantly reduces the differences observed in terms of inequality between countries, especially at the bottom of the income distribution. English-speaking countries, although less generous in terms of in-cash transfers than countries such as France, are more inclined to use in-kind transfers. The former countries also rely less on indirect taxation. This heterogeneity in practices may lead to bias if comparing the distribution of well-being (proxied through incomes) across countries, based on disposable income alone.

This paper addresses the question through a more comprehensive measurement of incomes in Luxembourg, a country characterized by a very high level of public expenditure per capita—the highest among OECD countries, even in Purchasing Power Parity (OECD, 2019)—and high tax revenue from indirect taxation, as is common among European countries. More specifically, we look at how the inclusion of elements of the tax-benefit system that are usually omitted changes the income distribution of Luxembourg resident households.

The main indirect taxes are Value-Added Tax (VAT) and excise duties that are based on the value or quantity of goods and services consumed. Using consumption surveys, such as the European Household Budget Survey (HBS), it is therefore possible to measure indirect taxes paid at the household level. However, these surveys generally do not contain enough income information for a detailed analysis of disposable income. We need to link the two types of datasets (see the proposals by Decoster et al., 2010; Figari and Paulus, 2015; Savage, 2017; De Agostini et al., 2017; Maitino, Ravagli, and Sciclone, 2017). In particular, De Agostini et al. (2017) show how Engel curves are estimated with HBS data, and how indirect taxation can be simulated using the EUROMOD model (grounded on the EU-SILC). In the current research, we rely on a similar method.

The consideration of in-kind transfers raises different issues than those for indirect taxes discussed above. Few microeconomic datasets contain information on the quantity of public services that are consumed by households. Moreover, as these services are often produced and distributed directly by the state, their prices are not directly observable. However, the monetary value of these transfers needs to be assessed in order to incorporate them into the analysis of income. As a result, the integration of in-kind transfers raises two main questions: what is the monetary value of these transfers, and who are the beneficiaries (and to what extent)?

The value of in-kind transfers is generally defined by the *production cost approach* (Smeeding et al., 1993), but it can also be measured by the value of what the household would have had to pay to afford the service by itself. With regard to the beneficiaries, the two most common strategies are the *actual consumption approach* and the *insurance-value approach* (Verbist and Förster, 2019). The former considers that a household that actually uses a service receives the transfers. The latter measures the amount needed to cover the needs of people who share the same characteristics. In line with this second approach, each individual belonging to the same group receives an identical amount of transfers. In the current work, we combine these two approaches to measure in-kind transfers from education, healthcare, childcare services, long-term care, and social housing. Unlike international comparison studies that have focused on in-kind transfers (for example Marical et al., 2008; Verbist and Förster,

2019), we use more accurate data for Luxembourg to obtain a more precise measurement of these transfers.

Taking into account cash and non-cash transfers for a better view of economic well-being leads to a final question: which equivalence scale should we adopt? When comparing monetary amounts, we need to consider "real" household total net income while taking into account economies of scale and objective needs, and then attributing to each household member a weight corresponding to the composition of the household and real needs: the equivalence scale. According to Radner (1997), using the same scale for cash and non-cash income can lead to inconsistencies. The standard equivalence scale does not take into account differences in non-cash needs, and therefore risks overestimating the equivalent income of households that are using public services, without really reflecting greater well-being. Therefore, the equivalence scale in the case of in-kind transfers must be modified. Alternatives have been proposed by Aaberge et al. (2010) and Paulus, Sutherland and Tsakloglou (2010). We here test the sensitivity of our results to the equivalence scale used.

The remainder of the paper is organized as follows. Section 2 describes the data used in the analysis, and the different methodological steps that were followed to obtain the results: the microsimulation model, the simulation of indirect taxes, the imputation of in-kind transfers, and the definition of the equivalence scale. Section 3 presents the results. Our conclusion and a discussion of the policy implications are contained in Section 4.

Data and Method

Microsimulation

Our analysis is based on the EUROMOD microsimulation model. This model allows researchers to simulate most of the direct taxes and cash social transfers existing in European countries (Sutherland and Figari, 2013). The model is built on data from the EU-SILC, a survey that involves interviewing a representative sample of the population of each country on different sources of income, living

conditions, and the labor supply. It also contains detailed information on the socio-demographic structure of households, such as the age of all members, their level of education, and their marital status. Other information on health and well-being is also available. This dataset and the tax-benefit modeling allow researchers to simulate the disposable income of each household in the sample, and to assess the change in disposable income in the event of a modification to the data or tax-benefit rules.

We here use the Luxembourg EUROMOD input data set. The input database is composed of EU-SILC 2016 data (the reference year for income variables is 2015) that have been adapted to meet the constraints of the model, for example, missing data are imputed.[1] The EUROMOD data involves 3,836 households representative of the population residing in Luxembourg. Three households with aberrant values (negative disposable income or very high disposable income) were removed from the sample. In the results section, households including international civil servants were also removed, as they are subject to specific tax systems that depend on the international institutions in which they work. It is accordingly not relevant to take these households into account in the analysis of the Luxembourg tax-benefit system. The final sample comprises 3,643 households (9,525 individuals).

Simulation of Indirect Taxes

We follow the method proposed by De Agostini et al. (2017) to impute consumption expenditures in the Luxembourg EUROMOD input data. This method, already applied to ten countries of the EUROMOD consortium, consists of estimating Engel curves for the relationship between consumption and income (Banks, Blundell and Lewbel, 1997), using HBS data. Engel curves are estimated for 16 different aggregate categories of goods and services using several explanatory variables (disposable income of the household; age, sex, nationality, education and economic status of the household head; size of the household; number of active persons; and presence of a car in the household).[2] A simple unconditional demand equation is estimated for the aggregate categories with a high proportion of households with positive expenditures. For the other aggregate categories, either durables or non-durable expenditures, a two-step estimation procedure is followed: first, a probit model is used to estimate the probability that a household has positive expenditures in the aggregate category, second, a

conditional demand equation is estimated. This methodology uses the specification of Engel curves in a Quadratic Almost Ideal Demand System (QUAIDS), without relative price effects (Banks, Blundell and Lewbel, 1997).

Table 1 shows the aggregate categories considered, as well as the dependent variable and the type of estimation method applied for each category. To have the same reference year for income in the HBS and in the EUROMOD input dataset, we use the 2015 wave of the Luxembourg HBS, a survey that every year involves interviews with approximately 1,000 households residing in Luxembourg. To increase the sample size, the $t - 1$ and $t + 1$ survey data are added for year t, with expenditure and income variables updated at the price level of t.

The previously estimated parameters, based on HBS data, are used in association with identical socio-demographic variables from the EUROMOD database to impute consumption expenditures in the latter. The independent variable used for disposable income is the net income reported by the households in the HBS, while it is the simulated disposable income in the EUROMOD input data. The summary of the method can be found in Figure 1. A specific level of expenditure for each household in the EUROMOD input dataset, and for each category of goods and services, is then calculated. The EUROMOD input dataset, augmented for consumption imputed for each household, is referred to as EUROMOD+. To verify the consistency of the imputation of consumption in EUROMOD using HBS data, we checked that the weighted EUROMOD and HBS data are similar in terms of the main summary statistics of the used variables.[3] In addition, for the year 2015 (to have the same year for the two datasets), in Figure 2 we compare the mean level of expenditures observed in the HBS with the mean level of expenditures imputed in the EUROMOD input dataset. We distinguish the results by decile of equivalized disposable income; that is, disposable income divided by the OECD-modified equivalence scale.[4] The average amount of the expenditures per decile imputed in the EUROMOD+ are similar to those observed in the HBS.

The data about consumption were aggregated in 16 categories to estimate the Engel curves. However, and keeping in mind our final objective of evaluating the indirect taxes paid by each

household, we need to go into more detail to deal with the variety of tax treatments that apply within each category of aggregates. It may be the case that an *ad valorem* excise is imposed on a specific item in the aggregate category, but not on other components of the same category. Benefitting from the rich information embedded in the HBS—which covers 201 sub-categories of goods (grouped into 16 categories for the estimations)—we accordingly calculate the average proportion, for all HBS households considered together, of each sub-category in the aggregate category to which it refers. For example, we first measure the proportion of the sub-category "bread" in the "food & non-alcoholic beverages" aggregated category. We then use this weight to create the consumption sub-categories in the EUROMOD+ database. More specifically, if x percent of "food & non-alcoholic beverages" expenditures are devoted to "bread" in the HBS, the sub-category "bread" in the EUROMOD+ will be imputed by applying x percent to the level of expenditures in the category "food & non-alcoholic beverages" that was previously imputed. The proportion of each sub-category in the aggregate category is therefore the same for all households, but as each household has a personalized level of aggregate expenditure, the level of expenditure in each sub-category is specific to the household considered.

Once the amount of the expenditures has been defined for each sub-category of goods and services, and for each household, we calculate VAT rates and excise duties associated with each sub-category. This information is necessary to simulate taxes. The simulation of indirect taxes paid by household *i* for the good *k* is performed with the EUROMOD model using the following formulas:

• For Value-Added Tax (*VAT*):

$$VAT_{ik} = \frac{t_k}{1+t_k} e_{ik} \quad (1)$$

• For *ad valorem* excises (*ExA*):

$$ExA_{ik} = a_k e_{ik} \quad (2)$$

• For *specific* excises (*ExS*):

$$ExS_{ik} = \frac{s_k}{p_k} e_{ik} \quad (3)$$

• Overall, the indirect taxes paid *T* are:

$$T_{ik} = VAT_{ik} + ExA_{ik} + ExS_{ik} \quad (4)$$

with t_k the VAT rate for goods/service k, e_{ik} the total expenditures of household i for the goods/service k, a_k the *ad valorem* excise rate for the goods/service k, s_k the *specific* excise for the goods/service k and p_k the mean consumer price of the goods k subject to those specific duties.

Now that our database is ready and the formulae used to simulate indirect taxes have been defined, we chose to apply the most recent tax-benefit parameters available at the time of the study, namely 2018. Thus, in the rest of the paper, the results will be presented by simulating income, taxes, and other transfers using the rules in place in 2018.

In 2018, there were four VAT rates in Luxembourg. The standard rate was 17 percent, the "parking rate" 14 percent, the reduced rate 8 percent, and the super-reduced rate 3 percent. Excise duties only applied to alcohol, tobacco, and energy products. Given the different rates that could be applied to goods belonging to the same aggregate category and the presence of excise duties for some sub-categories only, we calculate an implicit tax rate for each aggregate category. The implicit tax rate is the sum of all indirect taxes levied on consumption, divided by the level of consumption expenditure. Implicit tax rates for the year 2018 are summarized in Table 2. Tobacco is by far the most heavily taxed category with an implicit rate of almost 200 percent, followed by the other categories subject to excise duties (alcoholic beverages and private transport). Rents and education are exempt from indirect taxes, as are an important part of health-related goods and services, which explains why the implicit tax rates are low or equal to zero for these categories.

To summarize, in this first step, we simulate the disposable income with the EUROMOD model based on the EUROMOD input data. Then we use estimates of the Engel curve parameters based on HBS data to impute consumption expenditures in the EUROMOD input data (now called EUROMOD+). Lastly, we implement the indirect taxation rules into the EUROMOD microsimulation model and apply them to the expenditures imputed to each household. We thus obtain the simulation of indirect taxes. The results obtained from this process are described in Section 3.

Imputation of In-kind Transfers

Transfers from the public sector are not only in the form of cash (family allowance, minimum assistance benefits, unemployment benefits, etc.) but also non-cash (free education, subsidized health sector, etc.). Developed countries have varying degrees of expenditure on the provision of public services, and the benefits associated with these subsidized services can compensate for the lack of cash transfers in some areas. In addition, studying income distribution in a population based only on cash transfers and direct taxes would bias the analysis. Therefore, it seems important to include in-kind transfers.

By in-kind transfers, here we only refer to public goods and services that generate an individual benefit to the user, such as education, health, housing (via the provision of social housing), or childcare subsidies. Collective goods and services (defense, public lighting, etc.) that benefit households in a more indivisible way are therefore not considered as social in-kind transfers, in line with the majority of studies focusing on in-kind transfers (Marical et al., 2008). In addition, as explained in Verbist and Förster (2019), the integration of in-kind transfers requires an attribution of a monetary value to these transfers and the identification of the beneficiaries.

With regard to the monetary value, services generally do not require any household payment and are not produced in a market (because they are supplied directly by public institutions). As a result, prices are unobservable. We follow Smeeding et al. (1993), and assume that the total value of in-kind benefits associated with a public service is equal to the total public expenditure related to this service. In other words, its monetary value is equal to the total cost of producing it. This is the so-called *production cost approach*. At the individual level, the value of a transfer is therefore defined as the cost per beneficiary of producing the service. Consequently, the value of in-kind transfers at the household level is taken as the sum of transfers received by all the household members. This method has the disadvantage of neglecting the efficiency and quality of the service provision. However, in some categories, prices are observable (for example, in the case of childcare), making it possible to determine the price that would have been paid by the family in the absence of public transfers.

For the identification of the beneficiaries, we need to consider that individuals do not necessarily use all the services and that for each service, the intensity of use may differ from one individual to another. For example, free public education only affects households with school-age children. Similarly, healthcare expenditure is on average more important for the elderly than for children. Income survey data, such as provided by the EU-SILC, usually do not (or only partially) provide information on the use of public services, or do not measure the intensity of use. To overcome this difficulty, two methods are generally detailed in literature with regard to allocating in-kind transfers. The first is the *actual consumption approach*, which is adopted when it is possible to identify the beneficiaries of public services. We use this approach for education, childcare services, and social housing. The second method, termed the *insurance-value approach,* may be used when the beneficiaries and intensity of use are not observable. This method groups individuals according to some observable characteristics (such as age or gender), and the monetary amount is then determined by the production cost of the service for the group divided by the number of individuals in that group. Consequently, all members of the same group receive the same amount of transfers. This imputed insurance value is the amount that an insured person would have to pay in each category (e.g. age group) so that a third-party provider (government, employer, other insurer) would have just enough revenue to cover all claims for such persons (Smeeding, 1982; Verbist, Förster and Vaalavuo, 2012). The benefit comes from the fact that, even if not used, individuals know that they have access to the public service in case of need. We use this approach for healthcare and long-term care.

The different approaches described above have been adopted in recent work on in-kind transfers (Marical et al. 2008; Paulus, Sutherland and Tsakloglou, 2010; Aaberge et al., 2010; Figari and Paulus, 2015; Aaberge, Langørgen and Lindgren, 2017). They nevertheless have some limitations that are important to highlight.[5] First, they assume that in-kind transfers do not create externalities (Paulus, Sutherland and Tsakloglou, 2010). This means that a non-beneficiary household would not obtain indirect advantages or losses related to the fact that other households are beneficiaries. Second, they consider that the production costs, measured with national accounts or other official statistics, are directly related to the service measured and that there is no inefficiency in public expenditure.

In what follows, we briefly describe the in-kind transfers we consider and their imputed values.

Education. The educational service is estimated using the actual consumption approach. We distinguish the service by different levels: (1) early-childhood education; (2) primary education; (3) lower-secondary education; (4) general upper-secondary education; (5) vocational upper-secondary education; (6) undifferentiated upper-secondary education, in which the vocational or general track is not specified; (7) post-secondary, non-tertiary education; and (8) tertiary education. Beneficiaries are identified as people aged sixteen and over who report being in education up to a specific level. For those under sixteen years of age, the information is missing. Thus, for children between four and fifteen years old inclusive (the age of compulsory schooling) we consider that children are in the level of education corresponding to their age. Individuals under four years of age are considered as being in early-childhood education if the parents declare that the child is attending a pre-school. It should be noted that students studying abroad and living there for their studies do not receive these in-kind transfers, as they do not depend on the Luxembourg education system. However, students going abroad to study can benefit from a mobility grant, which is already included in the measurement of cash income in EUROMOD.

The individual value of the in-kind transfer for a specific education level is assessed using data from the joint collection of information available from UNESCO, OECD, and Eurostat (UOE). The individual value of the transfer for each level of education is equal to public and international expenditure on the educational institutions (including core educational services and ancillary services) for each level, divided by the number of pupils/students enrolled in this level (expressed as full-time equivalent).[6] Expenditure for the tertiary education category excludes R&D expenditure, because this does not directly target education services (Paulus, Sutherland and Tsakloglou, 2010). Figure 3 summarizes the different values taken to approximate the monetary value of the education service. As indicated, the amount of in-kind transfers is higher for students in tertiary education, as well as for students in upper-secondary education. The specific program concerned (*brevet de maîtrise*) explains the very low level of in-kind transfers in the post-secondary, non-tertiary category. The number of courses is limited (eight on average), and these courses are spread over several years (usually three

years), because the students in this program are mainly working, and thus attend classes in the evenings or during weekends. In addition, the private cost of this program is relatively high per student in comparison with other training programs in Luxembourg (600 euros per year and 300 euros for each exam session).

Childcare services. Childcare services are subsidized in Luxembourg via the *Chèque-service accueil* (CSA) introduced in 2009. The CSA allows families with children under thirteen years of age or who have not left primary education to benefit from free or discounted formal childcare hours. The CSA is calculated according to different criteria: the taxable income of the household, the number of children, the birth order, the type of care structure (childcare center or childminder at the child's or the childminder's home), the number of hours of formal childcare, and the age of the child. Financial assistance through the CSA is capped at 60 hours per week, and at 6 euros per hour in a childcare center or 3.75 euros per hour for care provided by a childminder. Meal costs are also included (a maximum of 4.5 euros per meal, five times a week).[7] Taxable income is simulated in EUROMOD. In addition, the number, order, and age of children and the number of hours in a formal childcare service are available in the EUROMOD input database. Therefore, it is possible to simulate the amount of the cost of childcare that is covered by the state for each household. We assume full take up of the CSA and that the hours spent with a professional childminder are only spent with a certified childminder (*assistant parental*). In addition, the number of meals taken during care is not indicated, so we make the assumption that one meal is taken for each 4-hour window.

Households do not receive CSA as money, but are given vouchers and thereby pay a lower monetary amount to childcare providers. The gain associated with this scheme is therefore equal to the state contribution, as households would have had to pay the full cost in the absence of the vouchers. These vouchers thus allow households to reallocate to other goods or services the money that would have been used to pay for childcare.

Healthcare. For the health service, we use the *insurance value approach*. Thus, an individual receives the same amount of transfers as other people belonging to the same socio-demographic group (determined by age and gender). Based on health insurance data provided by the *Inspection Générale*

de la Sécurité Sociale, we divide the total expenditure on healthcare for each group by the number of people covered by the health insurance in the corresponding group. It is important to note that these aggregated data concern only Luxembourg residents covered by the country's health insurance scheme. Cross-border workers are excluded and therefore do not affect our estimates. In our data, healthcare includes:

- Hospital care
- Medical care
- Drugs
- Care from other health professions
- Dental care
- Laboratory analysis
- Maternity care, palliative care, preventive medicine, etc.

The average amounts per group are presented in Figure 4 and show that the healthcare needs of the elderly are much higher than those of young people. In addition, differences between men and women are observed mainly for the elderly and around the fertile ages (twenty–fifty years).

Long-term care. For long-term care, we also use the *insurance value approach* by gender and age group. As with healthcare, we assign to each individual the average monetary amount of in-kind benefits observed in each group. This is computed by dividing the total long-term care expenditure for a group by the number of persons covered by the public long-term care insurance in this group. The information is derived from long-term care insurance data and is provided by the *Inspection Générale de la Sécurité Sociale*. Only Luxembourg residents are included in these data. In-kind benefits for long-term care include essential aspects of life (mobility, personal hygiene, nutrition, etc.) support and counselling activities, and domestic tasks. Figure 5 shows the different values for the various groups. As is evident from the figure, it is mainly people aged eighty and above who receive high amounts in long-term care transfers.

Social housing. People in social housing pay rent at below the market price. Thus, instead of receiving cash benefits directly from the state to pay rent, they receive it indirectly by spending less on housing. The value of this in-kind transfer can be approximated by the difference between the rent paid and the market value of the housing. The difficulty lies in assessing this value on the private market; that is, the *imputed rent*. The different methods available for estimating imputed rent are described by Balcazar et al. (2017). The available data allow us to use two approaches, the first of which is a hedonic method based on a regression model. In this method, the value of the private market rent is estimated based on the characteristics of the dwelling and its occupants. However, unobservable differences are possible in the dwelling quality, between homeowners, and between non-market tenants and market tenants. To correct for this bias, we use a two-stage estimation model (Heckman, 1979). The second method to estimate the imputed rent is the Self-Assessment Approach, which is based on asking owner-occupiers and non-market tenants the value of the rent they estimate for their housing if it were placed on the market. However, as we can see in Figure 6, the data show a relatively large difference between observed rents and imputed rents with the self-assessment approach for Luxembourg. Moreover, households tend to evaluate their rent using rounded rather than precise values, which explains the presence of local maxima around rounded values such as 1500, 2000, and 2500. Self-assessed rents therefore do not seem to be a good criterion—at least for Luxembourg—to estimate the value of housing on the private market. With regard to the rental values imputed by the Heckman method, we observe a distribution that is close to that of the observed rents.[8] As evident from Figure 6, the two distributions do not totally overlap. This is not surprising, since the dwellings of homeowners and non-market tenants may have characteristics that differ from those of market tenants. In addition, since imputed rents are estimated using a regression model, there is also a certain margin of error between the imputed rent and the rent that would actually be observed if the housing were offered on the private market.

Accordingly, the value of in-kind transfers for social housing we use is the difference between the imputed rent estimated by the Heckman method and the rent actually paid by a household residing in social housing.

Equivalence Scale

Individual income is considered here as a proxy of economic well-being. However, comparing monetary amounts between households and individuals imposes the requirement that income is scaled in line with an appropriate reference. Such a transformation allows the inclusion of the economies of scale applicable by people living together. For example, a household composed of a couple does not need twice as many resources to achieve the same level of economic well-being as a single individual. Traditionally, the transformation has involved the division of the household disposable income by a so-called equivalence scale, resulting in an equivalent (or equivalized) disposable income. In a final step, the same equivalent income (as fixed at the household level) is attributed to each member of the household.

The equivalence scale therefore captures differences in needs and enables us to compare heterogeneous households. While traditional scales (the OECD-modified equivalence scale or the square root of household size) are suitable for assessing cash needs,[9] they no longer seem suitable for in-kind needs. Radner (1997) points out that public service needs vary greatly for different subgroups of the population, and that not taking these differences into account may result in overestimating the income and well-being of those who use public services. This is what Radner (1997) defines as the *consistency problem*. For instance, health-related risk varies across population groups and it is expected that a person in poor health will use more health care than the average. If this is the case, this person will be considered better off, on average, than a healthy person if needs are not taken into account.

In addition, economies of scale at the household level are generally irrelevant with regard to public services (one household member visiting a dentist will not reduce another member's dental care needs).

All of these reasons explain the importance of an equivalency scale adapted to public services. Two main alternatives to traditional equivalence scales like the OECD-modified one have been proposed in relevant literature: by Paulus, Sutherland and Tsakloglou (2010) and by Aaberge et al. (2010).

Paulus, Sutherland and Tsakloglou (2010) propose a "fixed cost" method to calculate an equivalence scale that takes into account the needs for public services. They consider that equivalent

disposable income is a measurement that already implicitly takes into account the presence of public services. Thus, the integration of a monetary value of these services into the income definition should not change the level of well-being of the household, and therefore its equivalent income. The "extended" equivalence scale must therefore be such that the disposable income adjusted by the OECD-modified scale is equal to the extended income (cash and non-cash income) adjusted by the *extended* equivalence scale. The calculation of the extended equivalence scale *e'* for a specific household is expressed as follows:

$$\frac{y}{e} = \frac{y+k}{e\prime} \Rightarrow e' = \frac{e(y+k)}{y} \tag{5}$$

where *y* is the household's disposable income, *k* the household's needs for publics services, and *e* the OECD modified equivalence scale. In the study by Paulus, Sutherland and Tsakloglou (2010), *k* is a function of public services spending by sub-group (age or education level), adjusted by the cross country variations in spending in the EU-15.

Aaberge et al. (2010) propose a theoretical framework that also accounts for the needs for public services in equivalence scales. The individual equivalence scale for non-cash income (SNCI) is measured by the ratio between the minimum needs in public services for an individual belonging to group *j* (women aged fifty to fifty-four, for example) and the minimum needs for individuals in reference group *r* (single men aged thirty-five to thirty-nine, for example). The minimum needs per group are measurable using infra-national public expenditure data. The need-adjusted equivalence scale (SNA) is the weighted sum of the equivalence scale for disposable cash income (SCI) and the equivalence scale for non-cash income (SNCI). Thus, the need-adjusted equivalence scale for household *h* is expressed as follows:

$$SNA_h = \theta_r SCI_h + (1 - \theta_r) \sum_j n_{hj} SNCI_j \tag{6}$$

where weight θ_r is the weight assigned to cash income for the reference group *r*, SCI_h the equivalence scale for disposable income of household *h*, $SNCI_j$ the modified equivalence scale for income from in-kind transfers for group *j*, and n_{hj} the number of individuals in household *h* belonging to group *j*.

This theoretically-based method requires the use of infra-national data to define minimum needs for public services, but these data are not easily accessible for all countries or not available if public services expenditure is determined only at the central level and not at the sub-national level. Thus, Aaberge, Langørgen and Lindgren (2017) also propose an alternative method to minimum needs in order to calculate $SNCI_j$. This alternative is based on subgroup averages rather than minimum needs. They also calculate a Simplified Needs-Adjusted equivalence scale in order to obtain an adjusted equivalence scale identical for all European countries and simple to use.

As our main objective is not primarily methodological, we do not show together, nor do we compare, the results derived for Luxembourg following both the approaches of Aaberge et al. (2010) and Paulus, Sutherland and Tsakloglou (2010).[10] However, we can highlight their main differences through a simple example, as developed in Table 3 which furthermore illustrates the consideration of the traditional OECD-modified scale.

Let us assume three households (A, B and C) consisting of one person and having a monthly cash (disposable) income of 2,600 EUR, 4,340 EUR and 8,170 EUR respectively. Using the OECD-modified equivalence scale (which value is here 1 for all households) to derive the well-being of households, it can be shown that those cash income lead to a relative Gini coefficient of 0.246.

The (relative) Gini coefficient is an index with a value between 0 and 1, increasing if inequalities in equivalent incomes become greater (zero would indicate perfect equality; the same income for all). It is equal to the absolute Gini index (the average absolute difference between incomes; 2,476 EUR in this example) divided by twice the average income (5,037 EUR). These two indicators are not concerned with the same notion of inequality; the first measures the relative differences in equivalent income between members of a population, while the second refers to the absolute differences in equivalent income between them. The relative Gini index will not change if equivalent income increases in the same proportion for all (scale invariance), even though this increase would change the absolute gap and thus the absolute Gini. Conversely, if equivalent income increases by the same absolute amount for all, the absolute Gini will not change (translation invariance); the gap in income between individuals

remains constant, while the relative Gini will change. The use of these two indicators allows us to better understand the evolution of inequalities from two different perspectives.

Suppose additionally that all three households are faced with an additional need for public services amounting to 1,730 EUR per month for A, 1,370 EUR for B and 1,800 EUR for C. These additional needs, for example for health care or education, show differences in needs compared to cash income. Note that the values of cash and non-cash incomes retained for Table 3 are chosen so as to reproduce the Gini coefficients resulting from the forthcoming analysis for Luxembourg (see Table 7), while at the same time approximating the relative incomes and needs between the low, middle and high deciles as shown in Figure 2 and Table 5, also for Luxembourg.

Using the OECD-modified scale again, yet to the extended income as often encountered in the literature, drive us to an equivalent income of 4,330 EUR, 5,710 EUR and 9,970 EUR for households A, B and C respectively. Compared to the situation where cash income is considered alone, the average extended income and well-being are significantly higher (6,670 EUR compared to 5,037 EUR previously) whereas the absolute Gini is slightly increased only (2,507 EUR compared to 2,476 EUR). Altogether, the relative Gini coefficient is reduced (0.188 with in-kind transfers; 0.246 with cash income alone). This decrease results from taking into account an assumed invariant equivalence scale (1, hence the same economies of scale for the three households) while some income is added, through in-kind transfers, but not in the same proportion to cash income for the three households (67% = 1,730 EUR/2,600 EUR for A, 32% for B and 22% for C). We therefore introduce a discrepancy between additional benefits and needs.

Let us now consider the approach of Aaberge et al., instead, and say that household B belongs to the so-called "reference group". "θ_r" in equation (6) is 4,340 EUR/ (4,340 EUR + 1,370 EUR) = 0.760, "SNCI" is 1.263 (=1,730 /1,370) for A, 1 for B and 1.314 for C (households A and C are facing greater needs for in-kind transfers, in absolute terms, than household B), while "SCI" is 1 for all. This leads to an equivalent "SNA" scale of 1.063 for A (=0.760*1+0.240*1.263), 1 for B and 1.075 for C. Therefore, the well-being or equivalent income according to the Aaberge et al.'s approach is 4,073 EUR, 5,710 EUR and 9,271 EUR respectively. The Aaberge et al.'s approach leaves household B (reference group)

unchanged in terms of its measurement of well-being, compared to the situation where the OECD-modified scale is applied, while households B and C have their measurement of well-being reduced, in proportion of what is observed for B, as their need scale now exceeds 1.

As a result, on the one hand, the average welfare according to Aaberge et al. is lower than when the OECD-modified scale was applied (6,351 EUR for the former; 6,670 EUR for the latter). However, on the other hand, the absolute impact of applying the Aaberge et al.'s approach, compared to the OECD-modified scale, is greater for the (richer) household C (from 9,970 EUR down to 9,271 EUR) than for A (from 4,430 EUR down to 4,073 EUR). Consequently, the absolute Gini is also reduced (2,310 EUR compared to 2,507 EUR when the OECD-modified scale is applied), leaving a similar relative Gini in both situations (0.182 if the Aaberge et al.'s method is applied; 0.188 with the OECD-modified scale).

Alternatively, Paulus, Sutherland and Tsakloglou (2010) basically consider, when deriving the welfare level, that changes in the equivalent scale should cancel out or compensate for the increase in the extended income due to public services. This would lead, through equation (5), to an equivalent scale of 1.665 for A (i.e. (2,600 EUR+1,730 EUR)/2,600 EUR), 1.316 for B and 1.220 for C. Altogether, the distribution of well-being, compared to that resulting from cash income alone, does not vary, which leads to an unchanged relative Gini coefficient (0.246 in our example).

The approach of Paulus et al. considers that the distribution of equivalized income should be unchanged before and after in-kind transfers, while in-kind transfers do play a role in the income distribution through the Aaberge et al.'s approach. In this respect, the latter method comes close to the traditional method of adding up income (cash and non-cash) and using simply the OECD-modified equivalence scale, while in addition considering in Aaberge et al. that in-kind transfers do not lead to the same economies of scale as cash incomes. [11] This is discussed and illustrated in a concrete way in Verbist et al. (2012).

For the time being and in order to go beyond the traditional equivalence scale while staying consistent with the OECD-modified scale used for cash income, we chose to follow for Luxembourg in the present paper the approach of Aaberge et al. (2010) which is widely and specifically applied in many recent papers (e.g., Figari and Paulus, 2015; Aaberge, Langørgen and Lindgren, 2017). In line

with Aaberge, Langørgen, and Lindgren (2017), we use the average approach, but with data from Luxembourg. We then estimate $SNCI_j$ by the ratio between the average amount of in-kind transfers received by group j and the average amount of in-kind transfers received by the reference group r.[12] The groups are based on age (groups of 5 years), the education level currently being attended, and gender. The reference group is composed of males aged between thirty-five and thirty-nine who are not in education. In addition, we use the OECD-modified equivalence scale for household disposable cash income SCI_h. Lastly, in the same way as Figari and Paulus (2015), we estimate θ_r by the ratio between the median disposable income and the median extended income (including cash and non-cash income) of the reference group r. We refer to this equivalence scale measured with the Luxemburg data as the "needs-adjusted Luxembourg scale."

To evaluate the importance of the needs-adjusted scale and the sensitivity of our results, in Section 3 we calculate inequality indicators using the OECD-modified scale, the simplified-needs adjusted scale from Aaberge, Langørgen and Lindgren (2017), and the needs-adjusted Luxembourg scale. Table 4 illustrates the value of the different equivalence scales for certain types of households.

Results

We first present the results concerning the distribution of indirect taxes by decile of equivalent disposable income (as measured through the OECD-modified scale) in Figure 7. The proportion of indirect taxes paid by the "richest" 10 percent represents more than 15 percent of the indirect taxes collected from resident households, against around 5 percent for the poorest 10 percent. This is because wealthier households consume more in absolute terms. However, this figure only shows the distribution of the total amount distributed by deciles; it does not provide any information on the progressivity of indirect taxes, since this figure does not express indirect taxes as a proportion of income. Thus, although one household may pay more indirect taxes than another, this does not necessarily imply that the tax burden as a proportion of income is higher for the first household. We return to this point through Table 5 below.

If we now turn to the distribution of total in-kind transfers distributed by decile (see Figure 8) we observe, however—as Paulus, Sutherland, and Tsakloglou (2010) did for some countries—that educational in-kind transfers are more strongly concentrated in the first deciles (in Luxembourg, 16 percent of total in-kind transfers for education are received by the poorest 10 percent, compared with less than 10 percent in deciles six to ten). This result is due to the greater presence of households with children in the first deciles of equivalized disposable income. The concentration in the first deciles is even more pronounced for childcare. As with education, there are more households with children in the first deciles, and since the childcare in-kind transfers are means tested, this increases the concentration of total transfers in the bottom deciles.

Total transfers for health and long-term care seem to be more equitably distributed across the income distribution. However, the proportion is somewhat higher in the upper deciles, due to the greater presence of older people receiving more healthcare and long-term care. In-kind transfers for social housing are highly concentrated in the first deciles, but we note that some households in the upper deciles receive some part of this type of in-kind transfer. This can be explained by the fact that even if the economic situation of the household has improved, a social tenant is not forced to leave their dwelling. As with indirect taxes, Figure 8 shows which deciles receive more in-kind transfers, in absolute terms, but does not indicate the amount of these transfers as a proportion of household income. This last point is an important element for the evaluation of the effects of in-kind transfers on relative income inequality.

Table 5 decomposes household income by equivalized disposable income decile. This decomposition is expressed as a percentage of the average household disposable income for each decile. Therefore, we express each tax-benefit component as a proportion of the average disposable income for each decile. The 10 percent of individuals with the highest cash standard of living are found in households with an original income (capital/property income, labor market income, and private transfers net of social insurance contributions paid by employers or the state) higher than their disposable income (original income represents 118.1 percent of disposable income). The value of the cash transfers received by these households does not compensate for the direct taxes paid by them. By

comparison, in all the other deciles the average household original income is lower than the average household disposable income. Overall, the average household original income in the total population corresponds to 89.3 percent of the average disposable income. Thus, the "direct" part of the tax-benefit system (cash benefits, direct taxes, and social insurance contributions), on average increases household income.

When public pensions are included, the gross income (original income added to public pensions) of the households in deciles four to ten is higher than the average disposable income of the decile. We can also note that public pensions represent a larger proportion of disposable income in the highest deciles. This is due to the generosity of the Luxembourg pension system, which allows pensioners to be in relatively high deciles.

Social benefits, whether means tested or not, represent a larger proportion of disposable income for poorer households. Cash benefits represent only 2.0 percent of disposable income in decile ten compared with 45.7 percent in the first decile. However, the differences between deciles are smaller when considering non-means-tested social benefits. In contrast to benefits, the tax burden (including social security contributions and income tax) is higher for the richest households. The progressivity of the tax burden is, however, greater for income tax compared with that for social insurance contributions.[13] We observe that income tax actually has a small positive impact on household disposable income in the first decile, due to the presence of tax credits.

The incidence of indirect taxes in proportion of disposable income is higher in the bottom than the top of the income distribution (Table 5). Households in deciles eight, nine, and ten have a lower tax burden of indirect taxes (7.6 percent of disposable income or less) than those in the other deciles (between 7.7 percent and 8.6 percent). Thus, although richer households pay more indirect taxes in absolute terms (as shown in Figure 7), the tax burden of indirect taxes is lower for these households. Figure 9 offers a more detailed view of indirect taxes, and shows the incidence of indirect taxation (VAT and excise duties) in the original income and disposable income. We can clearly see the regressive effect of indirect taxation, as the tax burden is higher for poorer households. The shift from the original income to the disposable income (after direct taxes and social transfers) limits the

regressivity of indirect taxes, but it is still present. On the other hand, when considering the impact of indirect taxation according to expenditure or consumption, we observe that the tax is slightly progressive, with richer households devoting a larger proportion of their expenditure to pay indirect taxes. This slight progressivity is mainly due to the presence of reduced VAT rates or VAT exemptions that benefit the poorest households more. However, if we exclude actual rent expenditure, on which no indirect taxes are levied, we note that the progressivity with consumption is much less apparent. This result may be explained by the fact that renting a dwelling mainly involves poorer households, since the others are more often homeowners. It is therefore largely the fact that a greater proportion of the budget is devoted to (indirect tax-exempt) rent for poorer households that is responsible for the progressivity of indirect taxes with consumption.

In-kind transfers increase the average household resources by 31.7 percent, with strong heterogeneity across deciles (see Table 5). The increase is about 83.0 percent in the first decile, but reaches 11.5 percent in the last decile. The increase in income generated by taking public services into account is consistent with the results of Verbist, Förster and Vaalavuo (2012), showing that the same five public services in 27 OECD countries account for 76 percent of disposable income in the first quintile, compared with 14 percent in the last quintile (data for 2007). Similarly, Paulus, Sutherland and Tsakloglou (2010) observe that adding in-kind transfers for education, social housing, and healthcare to household disposable income would generate an increase between 18 percent and 27 percent depending on the country considered (five European countries are included in their study). The decomposition by quintile gives an increase of between 54 percent and 67 percent in the first quintile and between 8 percent and 13 percent in the last quintile, depending on the country.

Similar to the results of Verbist, Förster and Vaalavuo (2012), we find that education-related and health-related in-kind transfers appear to account for a much larger proportion of total household disposable income than the other in-kind transfers. Education and healthcare represent respectively 15.5 percent and 11.8 percent of average disposable income in Luxembourg, against 1.6 percent and 2.8 percent for childcare and long-term care, respectively, in the overall population. The regressive trend of in-kind transfers (as a proportion of disposable income) with income level can be observed for all

the public services considered (except for childcare in the second decile). Thus, health-related transfers increase household disposable income from 6.2 percent in the top decile to 20.3 percent in the bottom decile, and education from 3.7 percent in the top decile to 53.3 percent in the bottom decile. The monetary value of health-related transfers represents a higher share than education-related income only for deciles nine and ten. Childcare-related transfers increase disposable income for all deciles, but the increase is higher among households in the bottom deciles (more than 3 percent in the lowest four deciles) and they have almost no effect in the top deciles (an increase by 0.2 percent in the top two deciles). Long-term care has a limited effect on disposable income, with an increase of income lower than 5 percent, regardless of the position of the household in the income distribution. Lastly, social housing has a very small effect on income for both poor and rich households. This is due to the very low proportion of social housing in the total housing stock in Luxembourg.

Overall, our results show that only taking into account cash transfers and direct taxes gives just a partial view of the resources available to households. On average among resident households, extended income (involving all types of resources) is 24 percent higher than disposable income. The underestimation of the resources due to the measurement of disposable income progressively becomes more pronounced when the household standard of living decreases. This underestimation of income, particularly for the less well off, is likely to affect income inequality in a country, which is what we turn to below.

For the time being, and as shown in Table 6, comparing household income composition by household type is also very informative. We distinguish between people living alone and aged under sixty-five, and those who also live alone but are sixty-five or older. We also consider couples who live without children or other adults in the household. Lastly, we focus on single-parent households in which at least one of the children is under eighteen years old, and couples with at least one child under eighteen years of age. The remaining 25 percent of individuals belong to other more complex household configurations (several adults not linked by a particular family relationship, family with only adult children, families including three generations, etc.).

Unsurprisingly, the original income accounts for only 11.7 percent per cent of the average disposable income of singles aged sixty-five or above. On the other hand, pensions represent more than 100 percent of disposable income for households with a single person over sixty-four years of age or a couple with one member over sixty-four years of age. This is the main source of income for people aged sixty-five and over. Other social cash transfers appear to be a more important source of income for lone-parent families (30.4 percent of the average disposable income of these households compared with 8.8 percent for people living alone and under sixty-five years of age). Social insurance contributions correspond to a more important proportion of household's income for households that include a working age person, and income tax represents a lower proportion of household income for single-parent families compared with other types of households.

Indirect taxes reduce the disposable income of all households, but to a somewhat lesser extent for those that include single people and older people. With regard to in-kind transfers for education, they obviously strongly increase the income of households with children, but especially in the case of single-parent families. The same holds for childcare services, although the effect is smaller because the number of households concerned is much smaller. On the other hand, health transfers have a much higher impact for households composed of elderly people (an increase in average household income of about 20 percent, compared with less than 11 percent for other categories of households). Similarly, long-term care in-kind transfers increase the income of households composed of elderly people by 9 percent to 14 percent, compared with less than 1 percent for other types of households. As we have seen previously, social housing has a very limited effect whatever the decile, and the same is true for the different categories of households. Lastly, in-kind transfers represent about 10 percent of disposable income for households with members under sixty-five years old and without children, between 30 and 35 percent of disposable income for households comprising elderly people, about 50 percent for couples with children, and more than 75 percent for single-parent families.

Thanks to the extended income that has been evaluated, we can now examine economic well-being, measured as the equivalent extended income. By classifying individuals into deciles, we can see in Figure 10 that the position of individuals in the income distribution changes when we move from the

concept of equivalized disposable income (equivalized with the OECD-modified scale) to the concept of equivalized extended income (also equivalized with the OECD-modified scale).[14] We note that only 24 percent of individuals do not change their position in the income distribution, and that some individuals show very large decile variations (-5, +8). As previously explained, the use of an equivalence scale that does not take into account the needs for public services may result in overestimating the equivalent income of the households benefiting from them. Thus, by comparing the decile variations when we equivalized the extended income with the needs-adjusted Luxembourg equivalence scale, we can see that 56 percent of individuals would remain in the same decile and that very few changes take place beyond the decile just above or just below the initial decile.

Table 7 shows the evolution of inequality according to each component of the Luxembourg tax-benefit system. We chose to use the sequential accounting approach (see, for example, Fuest, Niehues and Peichl, 2010) to measure the redistributive effect of the tax-benefit system; that is, we sequentially add each component and calculate the percentage change in inequality indicators compared with the previous line. Although it is static and does not include the interactions between the different stages of redistribution (which can lead to path-dependence), this method is simple and follows a logical order in the structure of the Luxembourg tax-benefit system. We use the OECD-modified equivalence scale when the definition of income only includes cash income, and we introduce alternative scales (the Simplified Needs-Adjusted scale and the Luxembourg needs-adjusted equivalence scale) when non-cash components are included in the definition of income. We chose two inequality indicators: the relative Gini coefficient and the absolute Gini coefficient.[15]

We observe a sharp decline in inequality when including cash benefits and direct taxes (disposable income), with a reduction of 49.9 percent in the relative Gini and 45.3 percent in the absolute Gini. Public pensions, cash social benefits, and income tax have the largest effect on the reduction in relative inequality, while it is mainly income tax that is responsible for the decrease in absolute inequality. Indirect taxes additionally increase relative inequality by 2.5 percent, but decrease absolute inequality by 5.1 percent. The latter decreases because better-off households pay more indirect taxes in absolute terms (see Figure 7), thus the income gap between rich and poor becomes smaller. However, the less

well-off households pay a larger proportion of their income through indirect taxes (see Table 5), resulting in an increase in the relative Gini. Such an impact of indirect taxes on relative inequality is also reported by Figari and Paulus (2015), with an increase in the relative Gini coefficient of between 3 percent and 10 percent for the three countries under analysis.

The inclusion of in-kind transfers allows a further reduction in the relative Gini coefficient compared with disposable income after indirect taxes: from 23 percent to 26 percent depending on the scale of equivalence used (see Table 3 for an illustration of the main drivers leading to such differences in inequality indices when in-kind transfers are introduced). The effect on relative inequality thus seems less important than the effect of social benefits and direct taxes. With regard to absolute inequality, social in-kind transfers increase inequality by 5.2 percent (in comparison with inequality of disposable income post-indirect taxes) if the OECD-modified scale is applied, compared with a decrease of 15 to 18 percent if scales that adjust for public service needs are used. As noted earlier, the absence of adjustments for public service needs overestimates the equivalent income of certain categories of the population, leading to an increase in the income gaps in the population. Thus, needs-adjusted scales appear to have little effect on the measurement of relative inequality, but are important in the measurement of absolute inequality. The small difference in terms of relative inequality reduction between the OECD-modified scale and a scale based on the Aaberge et al. (2010) approach was already found by Verbist, Förster and Vaalavuo (2012).

Focusing on the results obtained with the "needs-adjusted Luxembourg" scale (where the results are similar to those obtained with the Simplified Needs-Adjusted scale), we note that public in-kind transfers allow for a more egalitarian distribution of equivalent incomes (the relative Gini drops by 24.7 percent) and reduce absolute differences in income between individuals in the population (the absolute Gini drops by 18.2 percent).

It is mainly education and health services that reduce relative inequality (a decrease of 12.4 percent and 9.5 percent, respectively, using the "needs-adjusted Luxembourg" scale); however, only education seems to have a significant effect on absolute inequality. Health, for example, has no effect on absolute inequality, because (according to the insurance approach and after correcting for differences in needs)

all individuals receive a very similar amount. Overall, the Luxembourg tax-benefits system allows a reduction in relative inequality of 61.3 percent and in absolute inequality of 57.5 percent.[16]

Conclusion

This article analyzes a more comprehensive definition of income, allowing for a deeper analysis of the distributive impact of the Luxembourg tax-benefit system. We use the extended income measurement already applied in other studies (Figari and Paulus, 2015). This is based on disposable income, from which we subtract the indirect taxes paid by the household, and to which the in-kind transfers received are added. Taking these two elements into account is important, because indirect taxes reduce households' cash income and in-kind transfers are a counterpart to the taxes paid by the households. As taxes are deducted from disposable income, it seems important to include the counterpart of these taxes (among other things, public services) to obtain a more accurate picture of the resources available to households.

By using survey data, imputation and simulation methods developed in the economics literature, we simulate the indirect taxes paid by households resident in Luxembourg and estimate a monetary value for the public services they receive. Our estimates show that indirect taxes and in-kind transfers represent 7.4 percent and 31.7 percent, respectively, of the average household disposable income in Luxembourg. We show that indirect taxes are regressive; they represent a greater tax burden for the poorest households. Conversely, in-kind transfers increase to a greater extent the incomes of the least well-off households. The in-kind transfers related to education and healthcare in particular increase household income. Similarly, households with elderly members or those with children benefit more from in-kind transfers (healthcare and long-term care for the elderly, and education-related in-kind transfers for families with children).

After adjusting for the needs for public services, we show that the Luxembourg tax-benefit system reduces relative inequality (measured by the Gini coefficient) by 61.3 percent, and absolute inequality (measured by the absolute Gini coefficient) by 57.4 percent. It therefore allows for a significant

reduction in income inequality. Although a large part of this reduction is attributable to the "direct" side of the tax-benefit system (direct taxes, cash social transfers, and social insurance contributions), in-kind transfers make it possible to achieve greater equalization of household well-being. On the other hand, indirect taxes slightly increase relative inequality (because the tax burden related to indirect taxes is greater among poorer households) without increasing absolute inequality, because richer households pay more indirect taxes in absolute terms.

In view of these results, it seems important to take into account the whole tax-benefit system (cash and non-cash benefits, and direct and indirect taxes) in order to obtain a clearer view of the efficiency and the generosity of the tax-benefit system in Luxembourg. Focusing purely on the cash components gives only a partial view of the efficiency of the tax-benefit system, while elements such as non-cash transfers make it possible to significantly reduce income inequality.

It is important to keep in mind that non-cash income has very different characteristics from cash income. The latter allows households to choose freely what they wish to do with this money—spend it on goods and services of their choice or save it—whereas non-cash income is "fictitious" money that is limited to the consumption of specific goods and services. The presence of public services and other in-kind benefits aims at supporting households to meet some needs, such as health and education, that they would have had to pay for themselves in the absence of these services. But in-kind income does not change the ability of households to consume more private goods and services of their choice. The measurement of extended income is therefore complementary to the measurement of disposable income.

In addition, imputation of in-kind transfers is based on strong assumptions. For example, the monetary value of some public services is allocated on the basis of socio-demographic characteristics rather than actual service use (the insurance-value approach). The use of databases to track the actual use of public services (such as healthcare) would allow a more accurate imputation of the monetary value of in-kind transfers for these public services, both in terms of income and needs measurement. Even for in-kind transfers imputed using the actual consumption approach, more precise data—such as on the type of school attended (private, public, international, etc.)—could also improve the quality of

the analysis. Wealth data, in-kind income from private sources (including imputed rent for homeowners), or data on capital gains, all of which are absent in the EU-SILC, could also temper the results on the distributional effect of the Luxembourg tax-benefit system. As better-off people benefit more strongly from such income, the progressivity of the system may be overestimated in our analysis.

The present analysis is a short-term one. For example, we have not integrated how receiving in-kind transfers today can influence outcomes tomorrow. Similarly, we have neglected the fact that public transfers are dependent on certain life stages (for example, public education transfers are received by children). In addition, adopting a life-cycle perspective could nuance the prevalence of in-kind benefits received by the less well off. Lastly, research on equivalence scales adapted to in-kind transfers is still under development, and the results of our study are likely to be sensitive on these scales as well. All of these issues would be worth being further explored in future research.

Acknowledgments

This work is part of the 2018-2020 project "Gathering expertise for a more comprehensive view of income components in Luxembourg," in collaboration with the Luxembourg Institute of Socio-Economic Research (LISER), the University of Luxembourg, and the Chambre des Salariés du Luxembourg (CSL). The results presented here are based on EUROMOD version I1.0+. EUROMOD is maintained, developed and managed by the Institute for Social and Economic Research (ISER) at the University of Essex, in collaboration with national teams from the EU member states. We are indebted to the many people who have contributed to the development of EUROMOD. The process of extending and updating EUROMOD is financially supported by the European Union Programme for Employment and Social Innovation "EaSI" (2014–2020). We make use of microdata from the EU Statistics on Income and Living Conditions, made available by Eurostat (RPP 213/2019-EU-SILC) and the national Household Budget Survey data, made available by the Luxembourg statistical office (STATEC). The authors wish to thank André Decoster and Toon Vanheukelom for their support while developing the indirect taxation module in EUROMOD, as well as Rolf Aaberge, François Maniquet, Félix Martins De Brito and two anonymous reviewers for their helpful comments. The results and their interpretation are the authors' responsibility.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by a funding from the “Chambre des Salariés du Luxembourg.”

Endnotes

1. See the country reports (2015–2018) for more information: https://www.euromod.ac.uk/using-euromod/country-reports.

2. Depending on the specifications, interactions between variables or polynomial terms were added as explanatory variables.

3. Additional details on the method can be found in De Agostini et al. (2017). The results of the Luxembourg model validation are presented in Vergnat, D'Ambrosio and Liégeois (2020).

4. The OECD-modified equivalence scale gives a weight of 1 to the first adult, 0.5 to additional persons (aged fourteen or more), and 0.3 per child (aged under fourteen).

5. For a complete literature review of studies on the distributive impact of public services before 2008, see Marical et al. (2008).

6. Public expenditure includes government (national or local) expenditure on education, while international expenditure refers to expenditure by international agencies and other foreign sources, including funds from international sources paid to governments or directly to educational institutions. These public and international sources are distinct from private expenditure, which includes two subcategories: households (that is, students and their families) and private entities other than households. Given the number of European and international institutions established in Luxembourg (there are several European and international schools in the country), it seemed important to us to take into account funding from international agencies. However, in 2016, the international source accounts for only 3 percent of expenditure on education (compared with 94 percent for the public sector and 3 percent for the private sector).

7. The precise value can be found in the amended law on youth, of 4 July 2008.

8. The rent value imputed by the Heckman method is available directly in the database because it is calculated by STATEC, the Luxembourg national statistical office.

9. See Liégeois et al. (2011) for an application to Luxembourg.

10. This would go beyond our objectives and is only done in a few articles, like in Verbist, Förster and Vaalavua (2012).

11. The interpretation of the results and their comparison may not be straightforward in practical situations, even opening the way for debate. In particular, additional deviations from the initial positions sketched in our simple example for the approaches of Aaberge et al. (2010) or Paulus et al. (2010) may arise, for example due to differences between the additional equivalent income resulting from public services and the corresponding "objective" needs (depending on the equivalent scale chosen). Furthermore, the Paulus et al. approach involves switching from an income-independent scale for cash income to an income-dependent scale when non-cash income is added, whereas the Aaberge et al. approach does not. When an income-independent equivalence scale is used, it can be interpreted as being based on the ratio of incomes that would provide equal welfare to a given household and a reference household. Needs are therefore expressed in relative rather than absolute terms. See the results for Luxembourg below and note 14 for more details.

12. This approach assumes that expenditure per capita for a group correctly reflects the public services needs of a group.

13. We have also reproduced Table 5 (available on request) by expressing each tax-benefit component as a proportion of the average household original income. The results are qualitatively the same as if we consider disposable income as a base, except for the social insurance contributions, which are regressive with original income but progressive if we consider disposable income.

14. Although the monetary value of some public services are attributed in this paper by the value of the needs for the service (the exact value of the needs is given to individuals) and needs in public services are adjusted with the needs-adjusted scale, there are changes in the position of households compared with others when moving from equivalized disposable income to equivalized extended income. One reason is that for some services, in-kind benefits are not equal to the value of the needs (e.g., childcare services are calculated using income, which is not used to construct the equivalence scale). In addition, indirect taxes are included in the concept of extended income and not in the concept of disposable income. Lastly, the weight assigned to cash income in equation (6) depends on the cash/non-cash

income split of the reference group, as explained by Aaberge, Langørgen and Lindgren (2013, 336): "even though NCj *["SNCIj", given the present paper's notations]* turns out to be rather high for some target groups, this effect is counteracted in the NA scale *[SNA]* by a rather low weight for public services (1-θr) for the chosen reference group, which means that the EU scale for cash income is given a relatively high weight." This means that while taking into account the need for public services, the NA scale *[SNA]* gives, for some households, a greater weight to cash income than the observed cash/non-cash income split.

15. As mentioned earlier, the relative Gini is equal to the absolute Gini divided by twice the average income.

16. The same conclusions emerge when using alternative indicators of income inequality, such as the inter-decile ratio (D9/D1) and the inter-decile difference (D9-D1).

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Author Biographies

Vincent Vergnat is Statistician in Public Health Administration. He was Research Associate in Economics at the Living Conditions Department of the Luxembourg Institute of Socio-Economic Research (LISER) and at the Economic and Social Well-being research group of the University of Luxembourg between 2018 and 2022. He obtained his PhD in Economics from the University of Strasbourg (2017). His research focuses on the effects of tax-benefit systems on poverty and income inequality, and also on how public policies impact household behavior.

Conchita D'Ambrosio is Professor of Economics, FNR PEARL Chair on socio-economic inequalities, at the Université du Luxembourg. She is an economist, with a PhD from New York University (2000). Her research interests have revolved around the study of individual and social well-being, its determinants, and the proposal of various measures that are able to capture its different aspects. She has been member of the editorial board of the Review of Income and Wealth since 2001 and chief editor of the same journal since 2007.

Philippe Liégeois is Civil Engineer, University of Liège, and holds a PhD in Economics from the Free University of Brussels (2001). He is a scientific advisor at LISER, Luxembourg. His research focuses on evidence-based policy assessment, including the long-term socio-economic effects of the ageing of the population. He is vice-president of the International Microsimulation Association.

Table 1: Engel curves estimation

	Dependent variable	2 steps: 1. Probit 2. Conditional demand	Main explanatory variable[a]
Non-durables	Log of E, the total expenditures on non-durables	no	Y
1.Food & non-alcoholic beverages	Budget share among "remaining" expenditures on non-durables	no	R
2.Alcoholic beverages	Budget share among E	yes	E
3.Tobacco	Budget share among E	yes	E
4.Clothing & footwear	Budget share among "remaining" expenditures on non-durables	no	R
5.Home fuels, electricity & water	Budget share among "remaining" expenditures on non-durables	no	R
6.Housing & rents	Budget share among E	yes	E
7.Household goods & services	Budget share among "remaining" expenditures on non-durables	no	R
8.Health	Budget share among "remaining" expenditures on non-durables	no	R
9.Private transport	Budget share among "remaining" expenditures on non-durables	no	R
10.Public transport	Budget share among E	yes	E
12.Recreation & culture	Budget share among "remaining" expenditures on non-durables	no	R
13.Education	Budget share among E	yes	E
14.Restaurants & hotels	Budget share among "remaining" expenditures on non-durables	no	R
15.Other goods & services	Budget share among "remaining" expenditures on non-durables	no	R
16.Durables	Log of D, the total expenditures on durables	yes	Y

Note: First, the total household expenditures D on durables (aggregate category 16) and E non-durables (1-15 gathered) are estimated, with D and E depending mainly on the household disposable income Y. Then, the proportion of expenditures within non-durables is estimated for each aggregated category identified for a two-step process, with, as the main explanatory variable, the total household expenditures on non-durables (E). Lastly, the proportion of expenditures within the remaining expenditures on non-durables (that is, E - the sum of expenditures derived from the previous step) is estimated for each aggregate category not considered yet (identified for a single-step process). The remaining expenditures on non-durables are denoted R.

[a] The main explanatory variables emphasized are considered through log format; that is, for example log(E), in the estimation. In each equation, socio-demographic variables are also included.

Source: Authors' calculations based on De Agostini et al. (2017)

Table 2: Implicit tax rate, Luxembourg, 2018

	Implicit tax rate 2018
Food & non-alcoholic beverages	3.0
Alcoholic beverages	20.6
Tobacco	197.9
Clothing & footwear	15.2
home fuels, electricity, & water	9.7
Housing & rents	0.0
Household goods & services	17.0
Health	1.2
Private transport	36.6
Public transport	3.0
Communication	16.8
Recreation & culture	6.3
Education	0.0
Restaurants & hotels	5.5
Other goods & services	2.8
Durables	16.1

Source: EUROMOD+, EU-SILC 2016, policy system 2018, authors' calculations.

Table 3: Accounting for in-kind transfers through the OECD-modified equivalence scale and the approaches of Aaberge et al. (2010) and Paulus, Sutherland and Tsakloglou (2010).

Deriving the Gini inequality index	Household *(each with 1 adult)* B is the reference unit	*Aaberge et al.'s approach*	*OECD-modified Scale considered*	
			IC and *INC*	*IC* only
Cash Income *IC*	A	2,600	2,600	2,600
	B	4,340	4,340	4,340
	C	8,170	8,170	8,170
In-Kind Transfers *INC*	A	1,730	1,730	0
	B	1,370	1,370	0
	C	1,800	1,800	0
Extended Income *IE = IC + INC*	A	4,330	4,330	2,600
	B	5,710	5,710	4,340
	C	9,970	9,970	8,170
θr *= IC(B) / IE(B)*		0.760		
SCI	A	1	1	1
	B	1	1	1
	C	1	1	1
SNCI_a {Aaberge} *= INC / INC(B)*	A	1.263		
	B	1		
	C	1.314		
SNA_a *= θr * SCI + (1-θr) * SNCI*	A	1.063		
	B	1		
	C	1.075		
WB_a *= IE / SNA_a*	A	4,073		
	B	5,710	WB = *IE*	WB = *IE*
	C	9,271		
Gini_a *or (*) Gini if considering the OECD-modified scale*	Relative *= Abs / (2*Avg)*	**0.182**	**0.188** (*)	**0.246**(*)
	Absolute *(Abs)*	2,310	2,507	2,476
	Avg income	6,351	6,670	5,037
Paulus et al.'s approach				
SNA_p *= SCI * IE / IC cf. Equation (5)*	A	1.665		
	B	1.316		
	C	1.220		
WB_p *= IE / SNA_p*	A	2,600		
	B	4,340		
	C	8,170		
Gini_p	Relative	0.246		

Notes : The suffix "*_a*" refers to Aaberge et al.'s approach, "*_p*" to Paulus et al.'s one. The meaning of other notations is either explicit (such as "*IC*") or most often referring to equation (6): "*SCI*" and "*SNCI*" stand for the equivalence scales for disposable cash income and non-cash income (i.e. in-kind transfers), "*SNA*" is the need-adjusted equivalence scale and "WB" is the well-being (measured as the equivalent income). "Gini" is evoking both the relative and the absolute Gini coefficients. Income, transfers and WB are expressed in EUR/month.

Table 4: Comparison of equivalence scales for different types of households

Gender	Age	Education	OECD Modified Scale	Simplified Needs-adjusted Scale[a]	Needs-adjusted Luxembourg Scale
	20-24		1.00	1.00	0.99
	35-39		1.00	1.00	1.00
Single men	50-54		1.00	1.00	1.04
	65-69		1.00	1.15	1.13
	80-84		1.00	1.32	1.49
	20-24		1.00	1.00	1.00
	35-39		1.00	1.00	1.03
Single women	50-54		1.00	1.00	1.05
	65-69		1.00	1.15	1.11
	80-84		1.00	1.32	1.68
	20-24		1.50	1.54	1.51
Couples	35-39		1.50	1.54	1.55
without	50-54		1.50	1.54	1.61
children	65-69		1.50	1.84	1.76
	80-84		1.50	2.18	2.69
Couples +	35-39				
1 child, boy, either:	3	No school	1.80	1.95	2.03
	7	Primary	1.80	2.23	2.34
	16	Secondary	2.00	2.49	2.54
	20	Tertiary	2.00	2.08	2.24

[a] The Simplified Needs-Adjusted Scale is from Aaberge, Langørgen and Lindgren (2017).

Table 5: Household income composition by source and decile of equivalized disposable income, as a percentage of household disposable income

	Decile										
	1	2	3	4	5	6	7	8	9	10	Total
Original Income	56.3	58.5	71.6	80.3	75.4	80.5	82.5	95.7	94.4	118.1	89.3
Public pensions	6.9	15.2	23.7	23.2	30.2	32.6	37.0	30.4	36.7	31.6	29.6
Non-means-tested benefits	15.0	14.1	11.1	9.2	9.1	6.8	4.7	4.2	2.8	1.9	6.1
Means-tested benefits	30.7	21.4	6.1	2.9	2.8	1.7	0.8	0.6	0.4	0.1	3.9
SIC (self-)employee	-9.0	-8.8	-10.7	-11.3	-10.7	-11.4	-11.3	-11.9	-11.9	-13.5	-11.6
Income tax	0.2	-0.2	-1.9	-4.3	-6.8	-10.2	-13.7	-18.9	-22.3	-38.3	-17.2
Disposable Income (DI)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Indirect taxes	-8.0	-7.7	-8.3	-8.4	-8.6	-8.4	-8.1	-7.6	-7.2	-5.3	-7.4
DI post indirect taxes	92.0	92.3	91.7	91.6	91.4	91.6	91.9	92.4	92.8	94.7	92.6
In-kind education	53.3	33.6	28.6	25.8	20.8	15.2	12.3	12.2	5.3	3.7	15.5
In-kind childcare	3.8	6.8	4.5	3.4	1.8	1.0	0.7	0.7	0.2	0.2	1.6
In-kind healthcare	20.3	18.5	16.5	15.3	14.7	13.3	11.9	10.5	9.1	6.2	11.8
In-kind long-term care	4.8	3.9	2.8	3.8	3.9	3.8	2.9	2.8	2.0	1.4	2.8
In-kind social housing	0.8	0.6	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Total in-kind	83.0	63.4	52.8	48.3	41.3	33.5	27.8	26.1	16.6	11.5	31.7
Extended income	175.0	155.7	144.5	139.9	132.8	125.1	119.7	118.5	109.4	106.2	124.4

Source: EUROMOD+ data based on EU-SILC 2016. The disposable income of EUROMOD data is simulated using the 2018 socio-fiscal system and expenditure is imputed using Engel curves. Authors' calculations.

Note: Deciles are constructed using the equivalized disposable income (modified OECD scale) of the household; each decile includes the same number of individuals.

Table 6: Household income composition by source and type of household, as a percentage of disposable income

	Household type					
	Single < 65 y.o.	Single > 64 y.o	Couple w/o child, both < 65 y.o.	Couple w/o child, at least 1 > 64 y.o.	Single parent, at least 1 child < 18 y.o.	Couple with children, at least 1 child < 18
Original Income	111.0	11.7	112.6	17.1	78.1	111.4
Public pensions	16.8	104.3	17.8	106.3	8.9	2.0
Non-means-tested benefits	2.0	0.2	1.8	0.5	17.4	12.3
Means tested benefits	6.8	6.0	1.1	2.0	13.0	3.0
SIC (self-)employee	-13.9	-4.7	-14.2	-4.9	-9.5	-13.0
Income tax	-22.7	-17.6	-19.1	-21.0	-7.8	-15.6
Disposable Income (DI)	100.0	100.0	100.0	100.0	100.0	100.0
Indirect taxes	-7.2	-6.5	-7.5	-7.3	-7.5	-7.4
DI post indirect taxes	92.8	93.5	92.5	92.7	92.5	92.6
In-kind education	1.5	0.2	0.6	0.0	59.7	35.1
In-kind childcare	0.0	0.0	0.0	0.0	5.7	4.0
In-kind healthcare	7.3	20.9	8.0	21.3	10.9	9.8
In-kind long-term care	0.7	13.9	0.7	9.0	0.7	0.6
In-kind social housing	0.4	0.1	0.0	0.0	1.0	0.0
Total in-kind	9.8	35.1	9.3	30.3	78.1	49.6
Extended income	102.6	128.7	101.8	123.0	170.5	142.1

Source: EUROMOD+ data based on EU-SILC 2016. The disposable income of EUROMOD data is simulated using the 2018 socio-fiscal system and expenditure is imputed using Engel curves. Authors' calculations.

Table 7: Gini coefficients and rate of change (in percent) in relative and absolute Gini coefficient for each component of the Luxembourg tax-benefit system

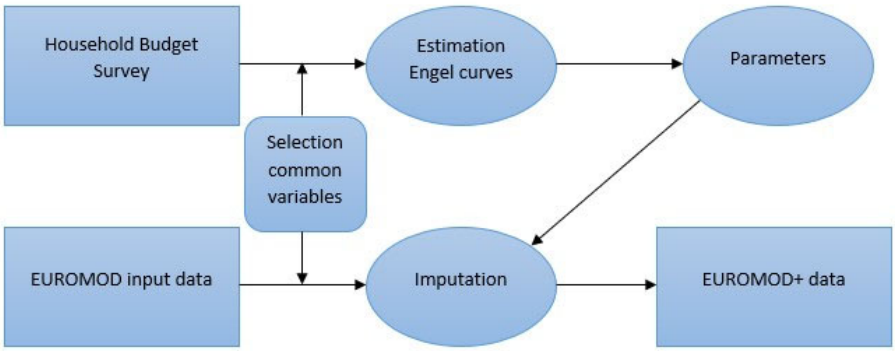
	Relative Gini			Absolute Gini		
	OECD-modified	Simplified Needs-adjusted[a]	Luxembourg Needs-adjusted	OECD-modified	Simplified Needs-adjusted[a]	Luxembourg Needs-adjusted
Original income	**0.479**			**1387.1**		
+Public pensions	0.363			1351.3		
Variation wrt original income	-24.2%			-2.6%		
+Cash benefits	0.302			1225.3		
Variation wrt public pensions	-17.0%			-9.3%		
-SIC (self-)employee	0.301			1110.9		
Variation wrt cash benefits	-0.2%			-9.3%		
-Income tax	0.240			759.1		
Variation wrt SIC	-20.3%			-31.7%		
=Disposable Income (DI)	**0.240**			**759.1**		
Variation wrt original income	**-49.9%**			**-45.3%**		
-Indirect taxes	0.246			720.7		
Variation wrt DI	+2.5%			-5.1%		
DI post-indirect taxes	**0.246**			**720.7**		
Variation wrt original income	**-48.7%**			**-48.0%**		
+In-kind education	0.213	0.212	0.215	748.4	621.8	600.2
Variation wrt DI post ind.taxes	-13.4%	-13.9%	-12.4%	+3.8%	-13.7%	-16.7%
+In-kind childcare	0.209	0.206	0.209	746.8	613.6	592.0
Variation wrt education	-2.0%	-2.9%	-3.0%	-0.2%	-1.3%	-1.4%
+In-kind healthcare	0.189	0.185	0.189	745.2	607.7	591.1
Variation wrt childcare	-9.5%	-10.2%	-9.5%	-0.2%	-1.0%	-0.2%
+In-kind long-term care (LTC)	0.189	0.182	0.186	759.1	611.2	590.6
Variation wrt healthcare	-0.1%	-1.3%	-1.9%	+1.9%	+0.6%	-0.1%
+In-kind social housing	0.188	0.182	0.185	758.4	610.6	589.7
Variation wrt LTC	-0.2%	-0.2%	-0.2%	-0.1%	-0.1%	-0.1%
=Extended income	**0.188**	**0.182**	**0.185**	**758.4**	**610.6**	**589.7**
Variation wrt DI post-ind. taxes	**-23.4%**	**-26.0%**	**-24.7%**	**+5.2%**	**-15.3%**	**-18.2%**
Variation wrt original income	**-60.7%**	**-62.0%**	**-61.3%**	**-45.3%**	**-56.0%**	**-57.5%**

Notes: Deciles are constructed using the equivalized disposable income (modified OECD scale) of the household; each decile includes the same number of individuals.

[a] The Simplified Needs-Adjusted scale come from Aaberge, Langørgen, and Lindgren (2017).

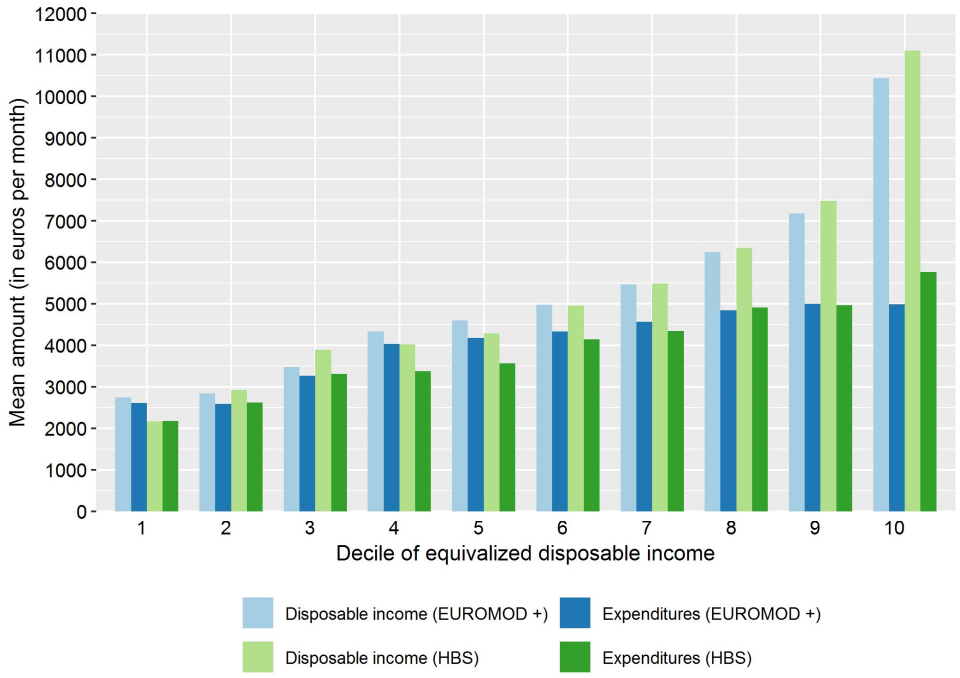
Source: EUROMOD+ data based on EU-SILC 2016. The disposable income of EUROMOD data is simulated using the 2018 socio-fiscal system and expenditure is imputed using Engel curves. Authors' calculations.

Figure 1: Summary of the imputation method for expenditures



Source: Authors' elaboration based on De Agostini et al. (2017).

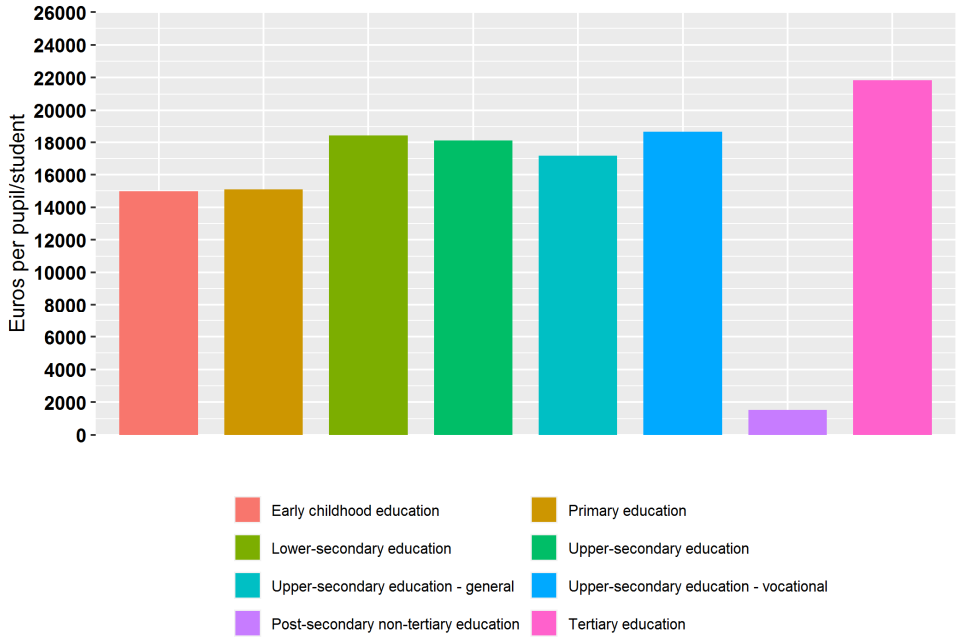
Figure 2: Comparison of disposable income and expenditures in HBS and EUROMOD, 2015



Note: The disposable income in EUROMOD+ is the disposable income simulated with EUROMOD (policy year 2015). Expenditures in EUROMOD+ are imputed using the Engel curves parameters.

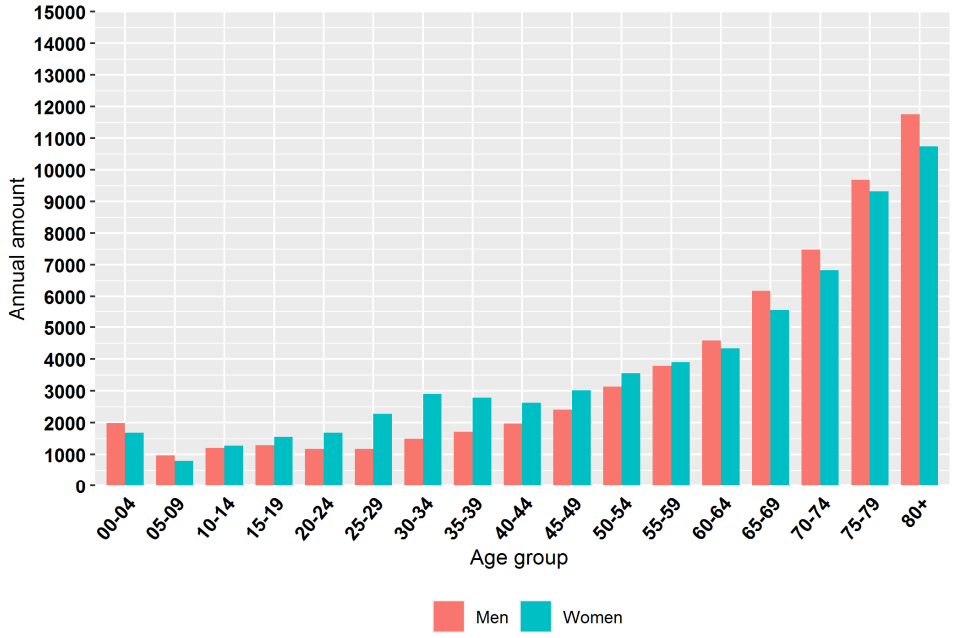
Source: HBS and EUROMOD+ (policy year 2015), Authors' calculations.

Figure 3: Annual value of in-kind transfers per capita by education level, 2016



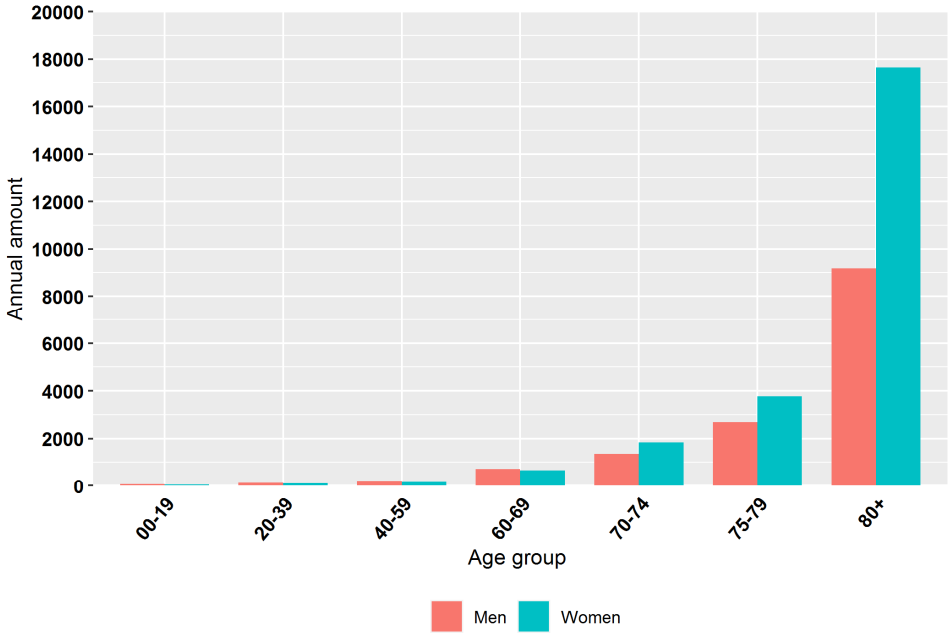
Source: UNESCO-OECD-Eurostat data collection (public and international expenditure on the educational institutions by education level and number of pupils/students (full-time equivalent) enrolled by education level), authors' calculations.

Figure 4: Annual value of in-kind transfers per capita for health, 2018



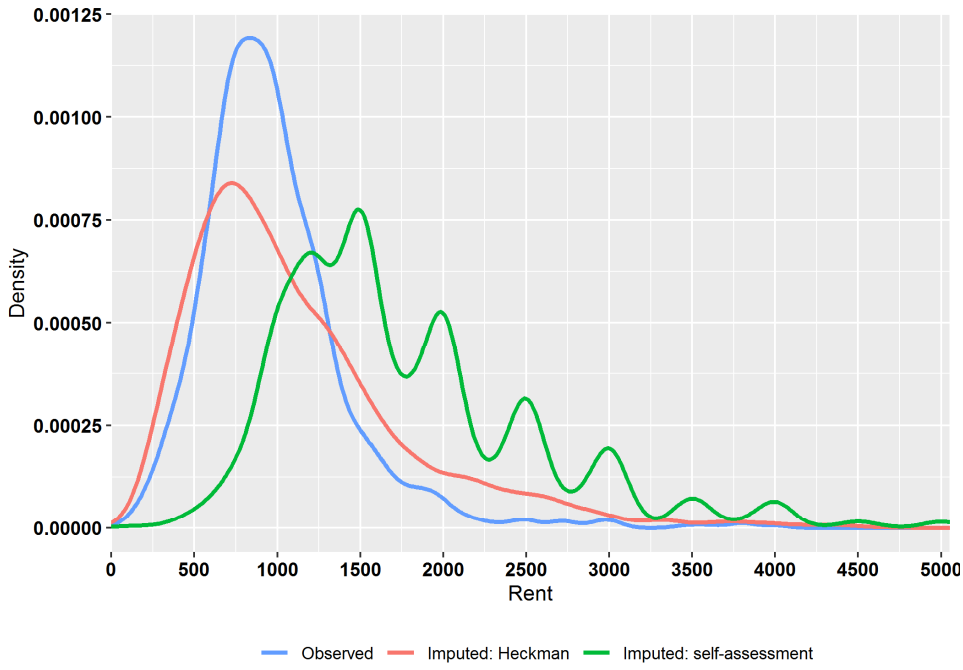
Source: Inspection Générale de la Sécurité Sociale, authors' calculations.

Figure 5: Annual value of in-kind transfers per capita for long-term care, 2018



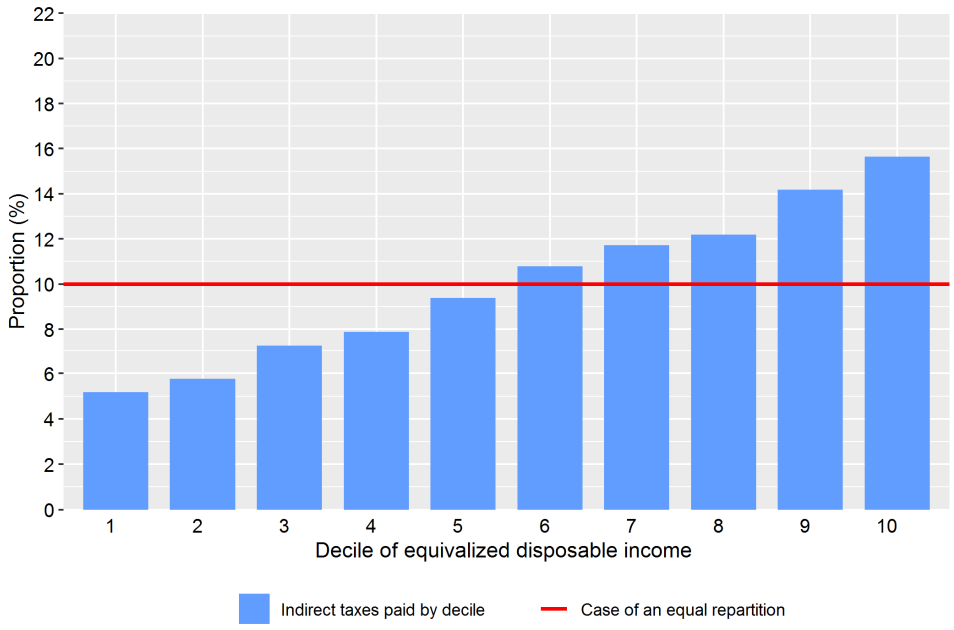
Source: Inspection Générale de la Sécurité Sociale, authors' calculations.

Figure 6: Observed, imputed, and subjective rent in EUROMOD



Source: EUROMOD+ data based on EU-SILC 2016.

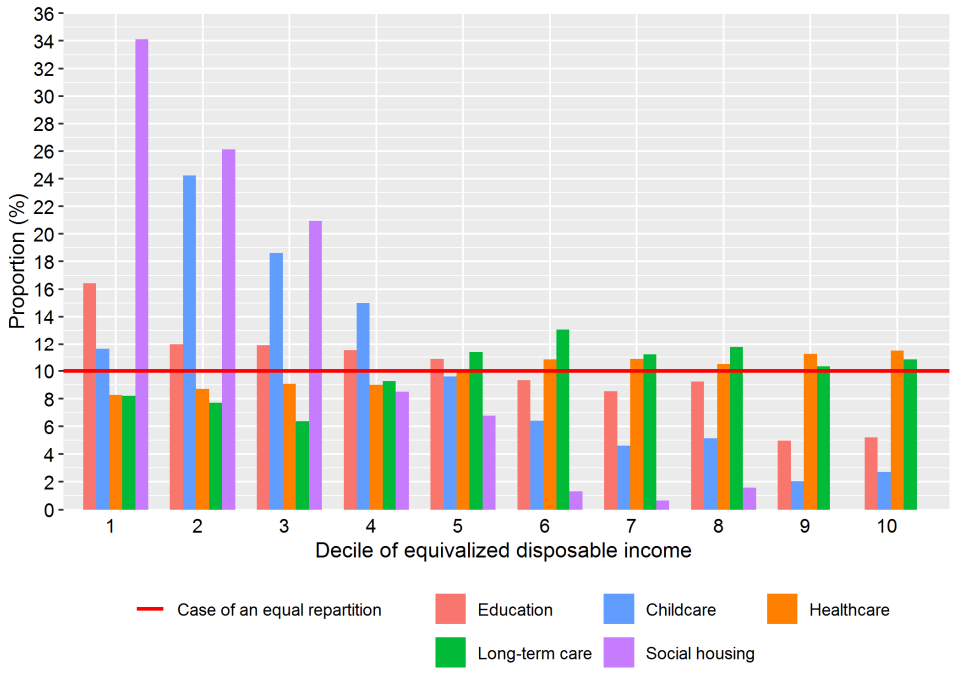
Figure 7: Aggregate allocation of indirect taxes by decile, 2018



Note: Deciles are constructed using equivalized disposable income (OECD-modified scale) of the household; each decile includes the same number of individuals.

Source: EUROMOD+ data based on EU-SILC 2016. The disposable income of EUROMOD data is simulated using the 2018 socio-fiscal system and expenditures are imputed using Engel curves. Authors' calculations.

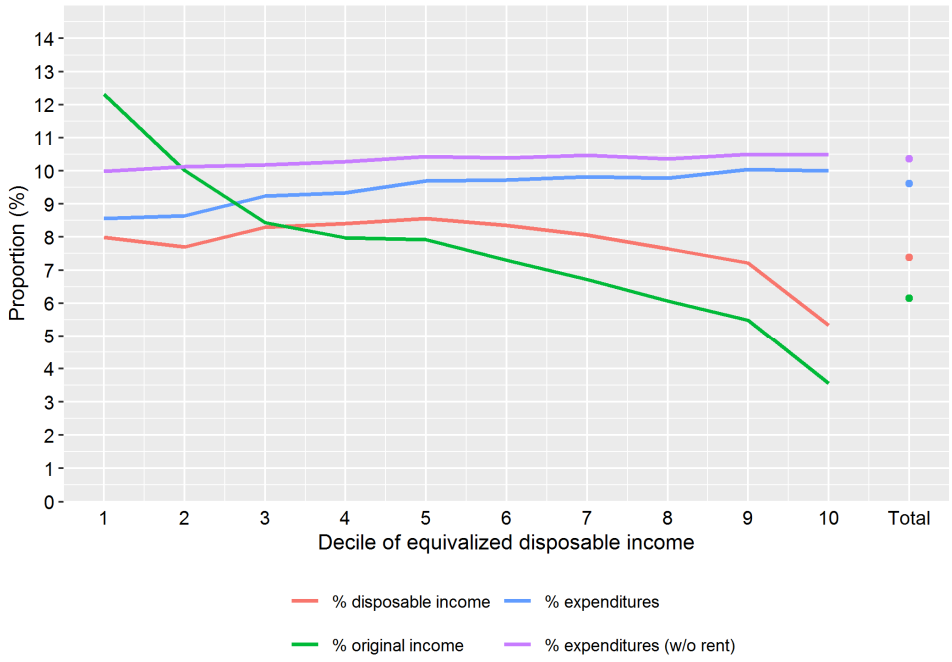
Figure 8: Aggregate allocation of transfers by decile, 2018



Note: Deciles are constructed using equivalized disposable income (OECD-modified scale) of the household; each decile includes the same number of individuals.

Source: EUROMOD+ data based on EU-SILC 2016. The disposable income of EUROMOD data is simulated using the 2018 socio-fiscal system and expenditures are imputed using Engel curves. Authors' calculations.

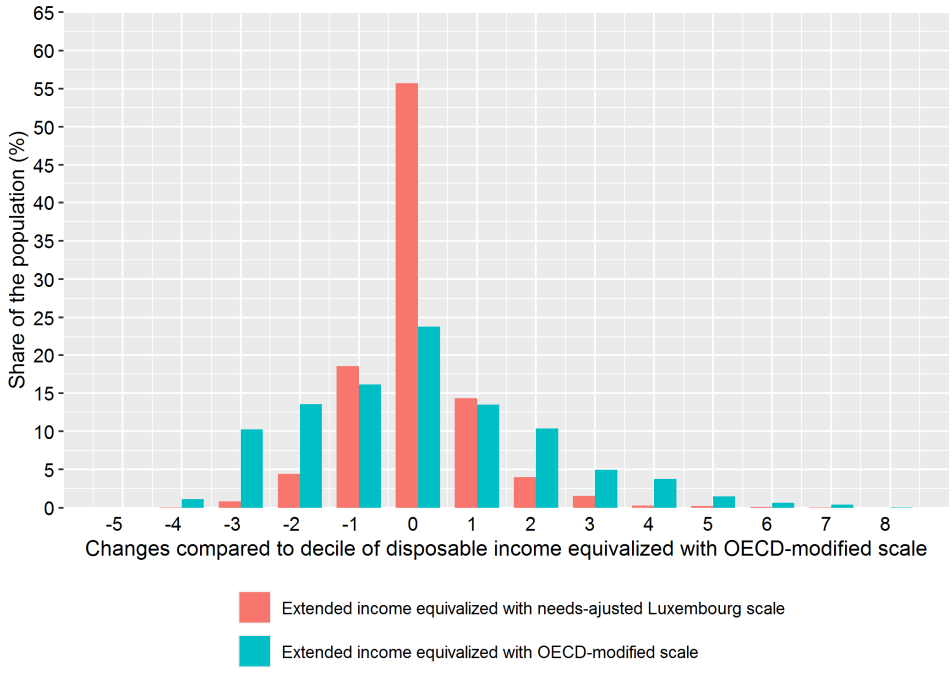
Figure 9: Incidence of indirect taxation in Luxembourg, 2018



Note: Deciles are constructed using the equivalized disposable income (OECD-modified scale) of the household; each decile includes the same number of individuals.

Source: EUROMOD+ data based on EU-SILC 2016. The disposable income of EUROMOD data is simulated using the 2018 socio-fiscal system and expenditures are imputed using Engel curves. Authors' calculations.

Figure 10: Comparison of decile of equivalized disposable income with decile of equivalized extended income by equivalence scale



Note: Each decile includes the same number of individuals.

Reading note: When moving from the decile of disposable income equivalized by the OECD-modified scale to the decile of extended income equivalized with the needs-adjusted Luxembourg scale, 55.7 percent of individuals remain in the same decile.

Source: EUROMOD+ data based on EU-SILC 2016. The disposable income of EUROMOD data is simulated using the 2018 socio-fiscal system and expenditure is imputed using Engel curves. Authors' calculations.