The distributive impact of the Luxembourgish tax-benefit system : a more comprehensive measure

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Abstract

This article studies the distribution of income in Luxembourg by integrating two aspects that were previously ignored: 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 are 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 have 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 due to education and health services.

Keywords: Income Distribution, Inequality, Microsimulation

JEL classification: D31, I30, H20, H40

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1 Introduction

The majority of income distribution studies consider only direct taxes and cash transfers (see, for example Fuest et al. (2010)). The measurement of income is thus limited to household disposable income. The household disposable income corresponds to the sum of primary incomes, replacement incomes, public cash social transfers and private transfers between households net of social contributions and direct taxes. This definition does not allow for a comprehensive measure of income since it neglects two important aspects of tax-benefit systems : indirect taxation and in-kind transfers. The main reason is the lack of data on consumption and use of public services in surveys used to analyse household's income. This is the case, for example, of the European Union-Statistics on Income and Living Conditions (EU-SILC) used in Europe to measure poverty and inequality. Ignoring these aspects can lead to an overestimation or underestimation of income inequality as well as distort international comparisons. For example, Garfinkel et al. (2006) show that taking in-kind transfers and indirect taxes into account in rich countries significantly reduce the differences observed in terms of inequality between and across countries especially at the bottom of the income distribution. It seems that English-speaking countries, although not very generous with in-cash transfers than country like France, are more generous with in-kind transfers. These countries rely also less on indirect taxation. The issue of indirect taxation and in-kind transfers may also be very relevant for Luxembourg. Indeed, Luxembourg is characterised by a very high level of public expenditure per capita, the highest among OECD countries, even in Purchasing Power Parity (OECD, 2019) and the tax revenue from indirect taxation is, as in most other European countries, high.

The main indirect taxes are Value-Added Tax (VAT) and excise duties. These taxes are based on the value or quantity of goods and services that are consumed. It is therefore possible to measure indirect taxes paid at household level using consumption surveys, like the European Household Budget Survey (HBS). However, these surveys generally do not contain enough income information to conduct a detailed analysis of disposable income. Methods have then recently been developed to link information from consumption surveys with information from income surveys (Decoster et al., 2010; Figari and Paulus, 2015; Savage, 2017; De Agostini et al., 2017; Maitino et al., 2017). De Agostini et al. (2017) present how Engel curves are estimated with Household Budget Survey data and how indirect taxation can be simulate into the EUROMOD microsimulation model. In this article we use a similar method to integrate expenditures into EU-SILC using the Luxembourgish component of the HBS.

The consideration of in-kind transfers raises different issues than those for indirect taxes. Indeed, few microeconomic datasets contain information on the quantity of public services that are consumed by households. Moreover, as these services are often produced directly by the State, prices are not observable. However, the monetary value of these transfers must be assessed to incorporate them into the analysis of income. Then, the integration of in-kind transfers raises two questions: what is the monetary value of these transfers? and who are the beneficiaries? The value of in-kind transfers is generally define 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. Concerning beneficiaries, the two most commonly used approaches are the *actual consumption approach* and the *insurance-value approach* (Verbist and Förster, 2019). The first considers

that a household that actually uses a service receives the transfers. The second measures the amount needed to cover the needs of people who share the same characteristics. Following this second approach, each individual belonging to the same group receive the same amount of transfers. In this article, we combine these two approaches to measure in-kind transfers from education, health care, child care 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 have a more precise measure of in-kind transfers.

Taking into account cash and non-cash transfers lead to a final question: what scale of equivalence to use? According to Radner (1997), using the same equivalence scale for cash and non-cash income can lead to inconsistencies. The usual equivalence scale does not take into account differences in non-cash needs and therefore risks to overestimate the equivalent income of households who are using public services without really reflecting a higher well-being. The equivalence scale in the case of in-kind transfers must be modified. Alternatives have been proposed by Aaberge et al. (2010) or Paulus et al. (2010). In this article, we test the sensitivity of the results to the equivalence scale used.

The main purpose of this paper is to measure the distributivity of the Luxembourgish tax-benefit system by taking into account, unlike previous studies on this country, indirect taxation and in-kind transfers. The sensitivity of the results to the equivalence scale used are also studied. The rest of the paper is organised as follows. The second section explains the data used in the analysis and the different methodological steps needed to obtain the results, namely the microsimulation model, the simulation of indirect taxes, the imputation of in-kind transfers and the definition of equivalence scale. Section 3 presents the results. Finally, the last section concludes and discusses the policy implications of the results.

2 Data and Method

2.1 Microsimulation

The analysis is based on the EUROMOD microsimulation model. This European model allows researchers to simulate most of direct taxes and cash social transfers existing in European countries (Sutherland and Figari, 2013). The model is based on data from the European Union-Statistics on Income and Living Condition survey (EU-SILC). This survey interviews a representative sample of the population of each country on different sources of income, on living conditions as well as on labour supply. It also contains detailed information on the socio-demographic structure of the household, such as the age of all members, level of education or marital status. Other information on health or well-being is also available. These data and the tax-benefit modelling allow the researchers to simulate the disposable income of each household in the sample. The main advantage of the microsimulation model is that it also makes it possible to simulate the distributive impact of reforms of the tax-benefit system.

In this article, we use the Luxembourgish 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 adapt to meet the constraints of the model. For example, income

variables are monthlyized, missing data are imputed... . [1] The EUROMOD input data includes 3 836 households residing in Luxembourg. 3 households with aberrant values (e.g. negative disposable income or very high disposable income) were removed from the sample. In the results section, households including international civil servants are also removed. The latter are subject to specific tax systems that depend on the international institutions in wich they work. It is, then, not relevant to take these households into account in the analysis of the Luxembourgish tax-benefit system. Finally, the sample is composed of 3 643 households (9 525 individuals).

2.2 Simulation of indirect taxes

The Luxembourgish part of the EUROMOD model does not include indirect taxation. This is due to the lack of information on household consumption in the EU-SILC survey. However, recent studies have attempted to overcome this limitation by imputing consumption into income survey data using expenditure data (Decoster et al., 2010; Figari and Paulus, 2015; Savage, 2017; Maitino et al., 2017). We chose to follow the methodology developed by De Agostini et al. (2017) to impute consumption expenditures in the Luxembourgish EUROMOD input data. This method, already applied to 10 countries of the EUROMOD consortium, consists of estimating Engel curves (Banks et al., 1997) using Household Budget Survey data. Engel curves are estimated for different aggregate categories of goods and services using several independant variables (disposable income, size of the household, age and education of the household head...). For aggregate categories with a high proportion of households with positive expenditures, a simple unconditional demand equation is estimated. For the other aggregate categories, a two-step estimation is made: first a probit to estimate the probability that a household has positive expenditures in the aggregate category and then a conditional demand equation is estimated. 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 HBS and in the EUROMOD input dataset, we use the wave 2015 of the Luxembourgish HBS. The Luxembourgish component of HBS interviews, every year, 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. Expenditure and income variables are updated at the price level of t.

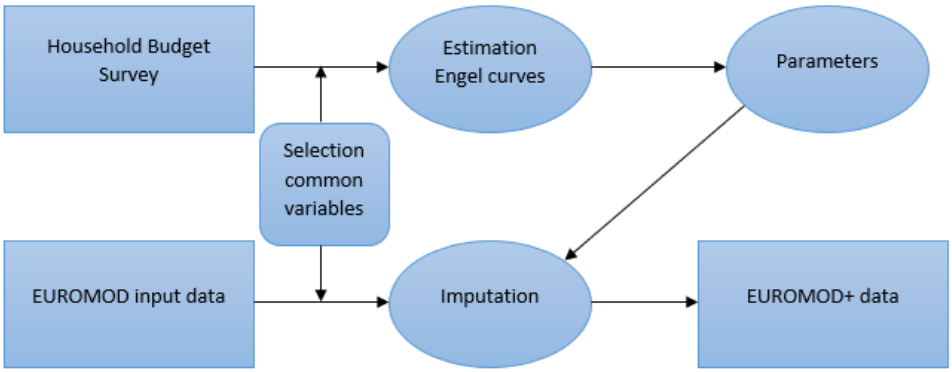
[1] The reader may refer to country reports (2015-2018) for more details on the construction of the EUROMOD input dataset: https://www.euromod.ac.uk/using-euromod/country-reports.

Table 1: Engel curves estimation

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

Note: Y: log household disposable income, E: log total household non-durable expenditure and R: log total remaining non-durable expenditure
Source: authors' calculations based on method from De Agostini et al. (2017)

Figure 1: Summary of the imputation method for expenditures

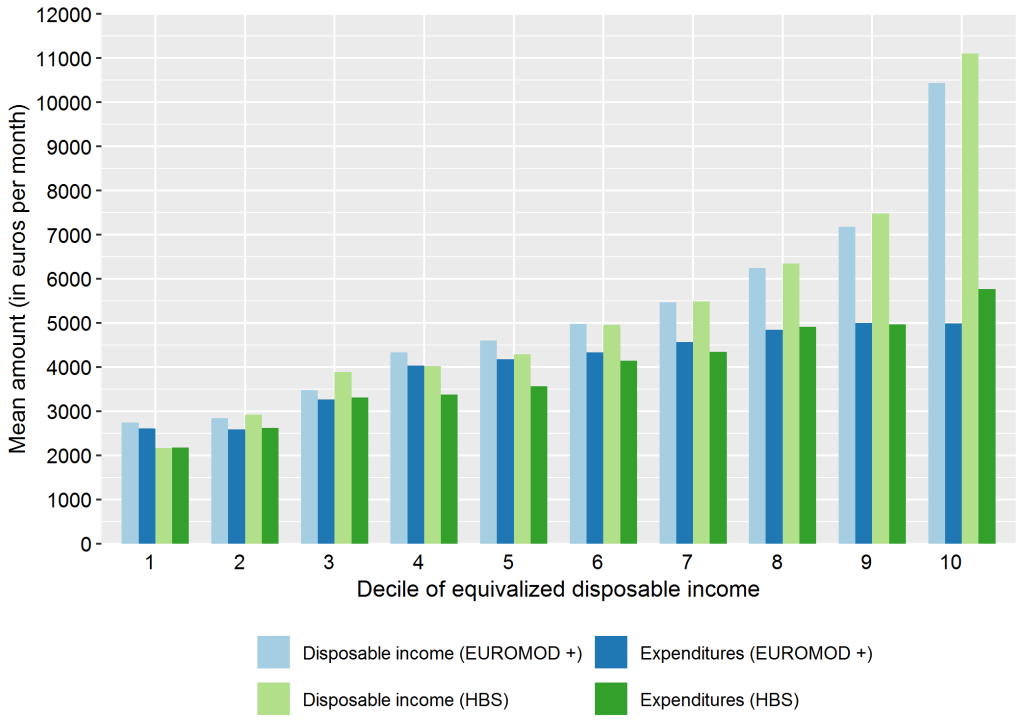


Source: Authors' elaborations based on the method developped by De Agostini et al. (2017).

The previous estimated parameters, based on Household Budget Survey data, are used in association with identical socio-demographic variables from the EUROMOD database to impute consumption expenditures. The independant variable use for disposable income is the net income report by households in the Household Budget Survey while it is the simulated disposable income in the EUROMOD input data. 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 summary of the method can be find in figure 1. To check the consistency of the imputation, we have checked that the weighted EUROMOD and

HBS data are similar.[2] In addition, for the year 2015 (to have the same year for the two dataset), we compare, in figure 2, the mean level of expenditures observed in HBS with the mean level of expenditures imputed in the EUROMOD input dataset, called EUROMOD+ (EUROMOD+ is the EUROMOD input data that includes imputed expenditures for each household).The average amounts of expenditures imputed in EUROMOD+ per decile are similar to those observed in HBS.

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.

The data have been aggregated to estimate the Engel curves but the HBS data contains more detailed information on consumption. There are 201 sub-categories in the HBS version we use. We calculated the average share, on all HBS households, of each subcategory in the aggregate category to which it refers. For example, we measured the share of "food & non-alcoholic" expenditures devoted to the subcategory "bread". We then use this weight calculated on the HBS data to create the consumption subcategories in the EUROMOD+ database. For example, if x% of "food & non-alcoholic" expenditures are devoted to "bread" in HBS, the sub-category "bread" in EUROMOD will be imputed by applying x% to the level of expenditures of the category "food & non-alcoholic" that was previously imputed. The share 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

[2]More details on the method, the reader can refer to De Agostini et al. (2017) The results of the Luxembourgish model validation are presented in the report Vergnat and Liégeois (2020).

expenditures, each households has a level of expenditure in each sub-category that differs from the others.

Once the amount of expenditure has been defined for each subcategory of goods and services and for each household, we define VAT rates and excise duties associated with each subcategory. This information is necessary to simulate taxes. The simulation of indirect taxes paid by household i for the good k are done with the EUROMOD model using the following formulas:

- For Value Added Tax (VAT):

$$\text{VAT}_{ik} = \frac{t_k}{1 - t_k} e_{ik} \tag{1}$$

- For ad valorem excises (ExA):

$$\text{ExA}_{ik} = a_k e_{ik} \tag{2}$$

- For specific excises (ExS):

$$\text{ExS}_{ik} = \frac{s_k}{p_k} e_{ik} \tag{3}$$

- In total, the indirect taxes paid T :

$$\text{T}_{ik} = \text{VAT}_{ik} + \text{ExA}_{ik} + \text{ExS}_{ik} \tag{4}$$

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

In Luxembourg, there are 4 VAT rates. The standard rate is 17%, the parking rate 14%, the reduced rate 8% and the super reduced rate 3%. Excise duties only apply to alcohol, tobacco and energy products. Given the different rates that can be applied to goods belonging to the same aggregate category and the presence of excise duties for some subcategories only, we calculate an implicit tax rate for each aggregate category. The implicit taxe rate is the sum of all indirect taxes levied on consumption divided by the level of consumption expenditures. 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%. The other categories subject to excise duties follow (alcoholic beverages and private transport). Rents and education are exempt from indirect taxes, as an important part of health-related goods and services, which explains why the implicit tax rates is low or equal to 0 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+). Finally, we program the indirect taxation rules into the EUROMOD mirosimulation 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.

Table 2: Implicit tax rate, Luxembourg, 2018

	Implicite taxe 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+, policy system 2018, authors' calculations

2.3 Imputation of in-kind transfers

Transfers from the public sector are not only cash (family allowance, minimum assistance benefits, unemployment benefits, etc.) but also non-cash (free education system, subsidized health sector...). Developed countries have varying degrees of expenditures on the provision of public services. The benefits associated with these subsidized services can compensate for the lack of cash transfers in some areas. Also, studying income distribution in a population based only on cash transfers and direct taxes biases the analysis. Therefore, it seems important to include in-kind transfers. In-kind transfers, in this study, 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 child care subsidies. Collective goods and services (defence, public lighting, etc.), which benefit households in a more indivisible way, are therefore not considered as social in-kind transfers in the framework of this study as in the majority of study focusing on in-kind transfers (Marical et al., 2008). In addition, as explained in Verbist and Förster (2019), the integration of in-kind transfers raises two questions: what is the monetary value of these transfers? and who are the beneficiaries?

The first question concerns the fact that these services generally do not require any household payment and are not produced in a market (because produced directly by public institutions), as a result prices are unobservable. As define by Smeeding et al. (1993), the total value of in-kind benefits associated to a public service is assumed to be equal to the total public expenditures related to this service. In other words, it is equal to the total cost of producing it. This is called the *production cost approach*. The value of the transfer, at an individual level, is therefore defined as the cost per beneficiary of producing the service. The value of in-kind transfers at the household level is, consequently, 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 (e.g. in the case of childcare), it is then possible to determine the price that would have been paid by the family in the absence of public transfers.

The second question is related to the fact that all individuals do not necessarily use all 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, health care expenditures is on average more important for elderly than for children. Income survey data, like 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 used in the literature to allocate in-kind transfers. The first one is the *actual consumption approach*. This approach is used when it is possible to identify the beneficiaries of public services. We use this approach for education, child care services and social housing. The second approach called *insurance-value approach* is generally used when the beneficiaries and intensity of use is not observable. This method groups individuals according to some observable characteristics (such as age or sex). The monetary amount is then determined by the production cost of the service for the group divided by the number of individuals in the group. Consequently, all members of the same group receive the same amount of transfers. The benefit come from the fact that, even if not used, individuals know that they have access to the public service in case of needs. We use this approach for health care and long-term care.

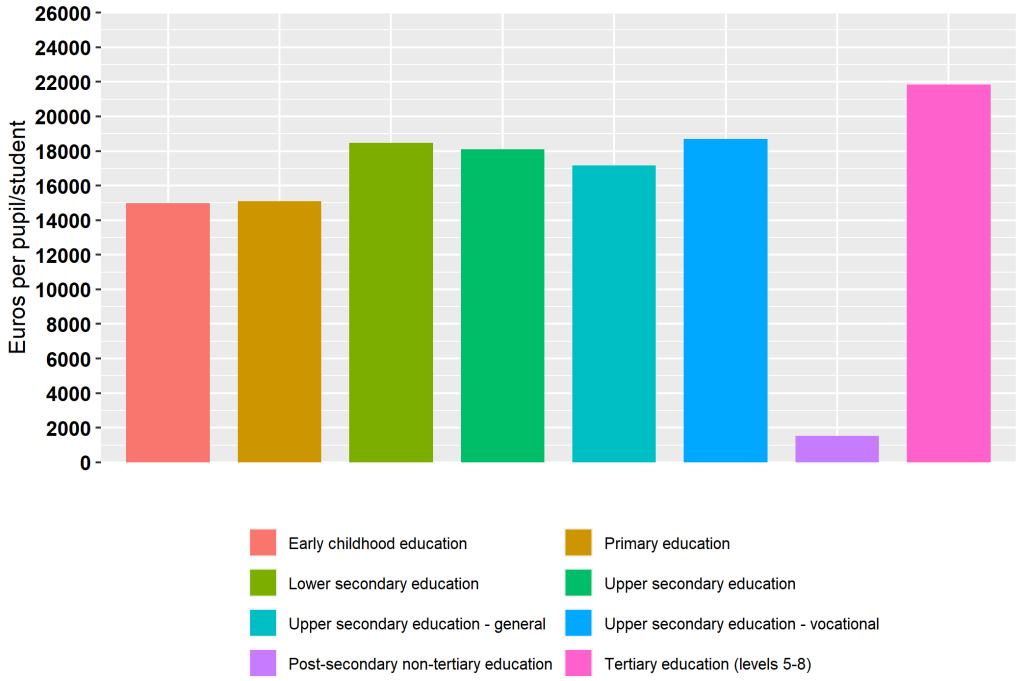
These different approaches are used in recent works on in-kind transfers (Marical et al., 2008; Paulus et al., 2010; Aaberge et al., 2010; Figari and Paulus, 2015; Aaberge et al., 2013) but they have limitations that are important to highlight.[3] Indeed, they imply that in-kind transfers do not create externalities (Paulus et al., 2010). This means that a non-beneficiary household would not obtain indirect advantages or losses related to the fact that other households are beneficiaries. In addition, they consider that 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 expenditures.

Education. The educational service is estimated using the actual consumption approach. We distinguish the educational 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 (if the track (vocational or general) is not specified), 7.post secondary non tertiary and 8.tertiary education). Beneficiaries are identified as people aged 16 and over who report being in education in a specific level. For those under 16 years of age, the information is missing. Thus, for children between 4 and 15 years old included (age of compulsory school) we consider that children are in the level of education corresponding to their age. For individuals under 4 years of age, they are considered in early childhood education if the parents declare that the child is going to a pre-school. It should be noted that students studying abroad and living there for their studies do not receive this in-kind transfers since they do not depend on the Luxembourgish education system. However, students going abroad for study can benefit from a mobility grant which is already included in the measurement of cash income in EUROMOD.

[3]For a complete literature review of studies on the distributive impact of public services before 2008, the reader may refer to Marical et al. (2008)

The individual value of the in-kind transfer for a specific education level is assessed using data from the joint collection of data of UNESCO, OECD and Eurostat (UOE). The individual value of the transfer for each level of education is equal to public and international expenditures 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 (in full-time equivalent). Expenditures for the tertiary education exclude R&D expenditures because these expenditures do not directly target education services (Paulus et al., 2010). Figure 3 summarizes the different values taken to approximate the monetary value of the service of education. We observe that the amount of in-kind transfer is higher for students in tertiary education as well as for students in upper secondary education. The very specific program concerned explains the very low level of in-kind transfer in category post-secondary non-tertiary.

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



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

Child care services. Child care services are subsidized in Luxembourg via the *Chèque-service accueil (CSA)* introduced in 2009. The *CSA* allows families with children under 13 years of age or who have not left primary education to benefit from free or discounted formal child care hours. The *CSA* is calculated according to different criteria: the taxable income of the household, the number of children and the rank of the child on the brotherhood, the type of care structure (childcare center or childminder at child's or child-minder's home), the number of hours of formal childcare and the age of the child. Financial assistance, via the *CSA*, is capped at 60 hours per week and at 6 euros per hour in childcare center and 3.75 euros per hour for children care by a childminder. Meal

expenditures are also included (max 4.5 euros per meal, 5 times a week).[4] Taxable income is simulated in EUROMOD; the number, rank and age of children and the number of hours in a formal child care services are available in the EUROMOD input database. Therefore, it is possible to simulate the amount of financial assistance received by each household for child care. However, we assume 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 the care is not indicated; we assume that one meal is taken for each 4-hours window.

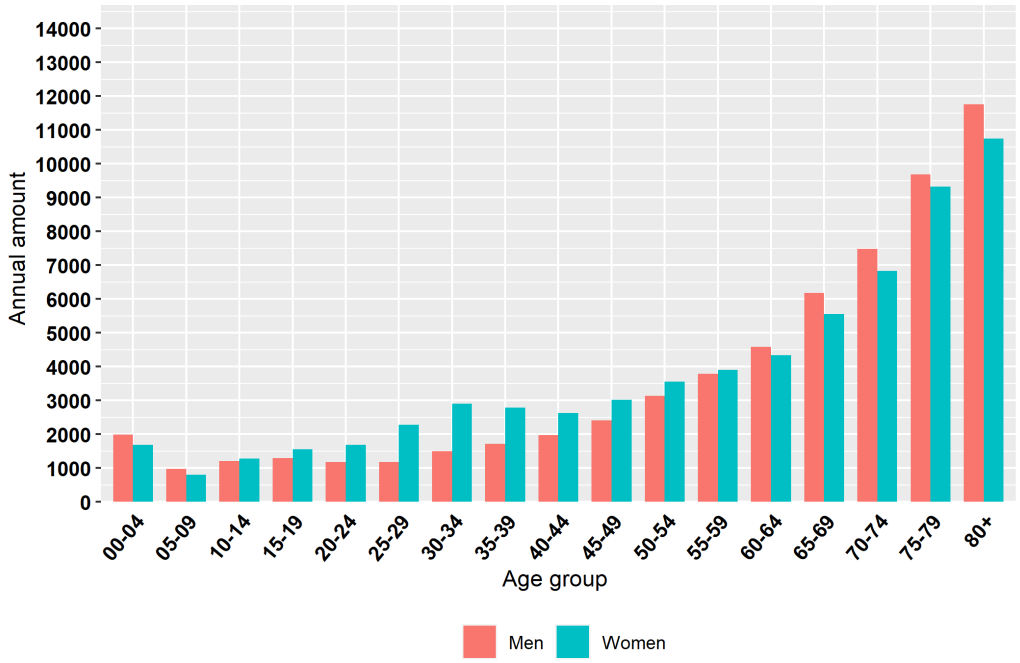
Health care. For the health service, we use the *insurance value approach*. Thus an individual receives the same amount of transfers as other people belonging to the same socio-demographic group. Socio-demographic groups is determined by age and sex. Based on health insurance data provided by *Inspection Générale de la Sécurité Sociale* we divide the total expenditure on health care 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 Luxembourgish residents covered by the luxembourgish health insurance. Cross-border workers are excluded and therefore do not affect our estimates. In our data, health care includes:

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

The average amounts per group are presented in Figure 4 and shows that the health care needs of elderly are much higher than those of young people. In addition, differences between men and women are observed mainly for elderly and around the fertile ages (20-50 years).

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

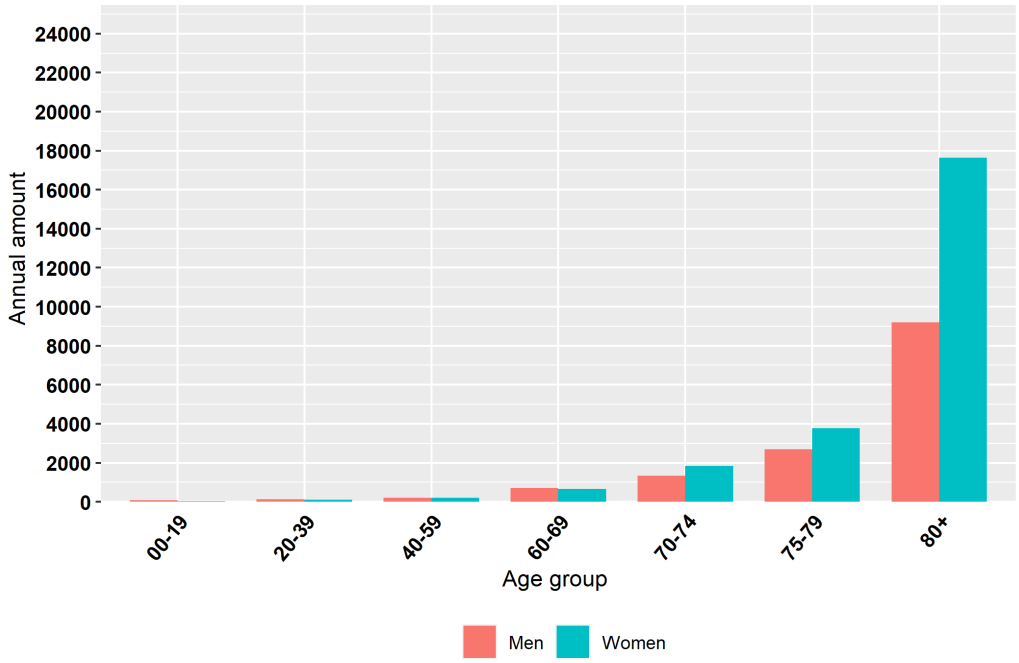
Figure 4: Annual value of in-kind transfers per capita for health



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

Long term care. For long-term care we also use the *insurance value approach* by gender and age group. As with health care, the average monetary amounts of in-kind benefits observed in each group are used. The individual amount is deducted by dividing the total long-term care expenditure for a group by the number of persons covered by long-term care insurance in this group. The data are derived from long-term care insurance data and are provided by the *Inspection Générale de la Sécurité Sociale*. Again, only Luxembourgish residents are included in these data. In-kind benefits for long-term care include essential acts of life (mobility, personal hygiene, nutrition, etc.), support and counselling activities and domestic tasks. Figure 5 shows the different values taken by groups. We can see that it is mainly people of 80 years old or older that recieve high amount of long-term care tranfers.

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



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

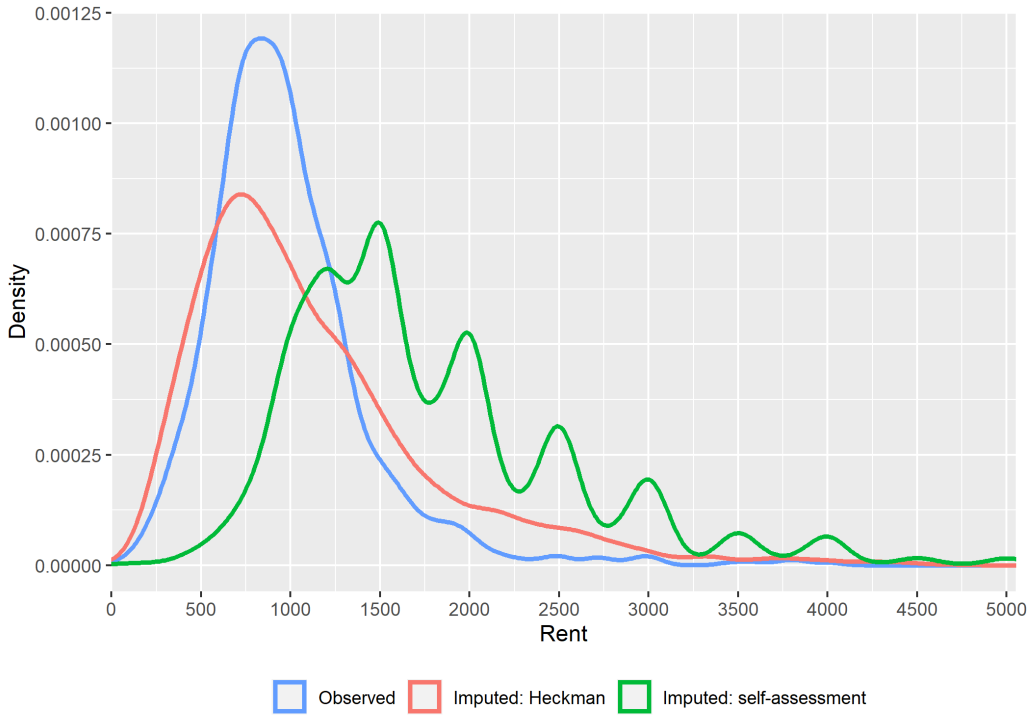
Social housing. People in social housing pay a rent below the market price. Thus, instead of receiving cash benefits directly from the state to pay the rent, they receive it indirectly by spending less for housing. The in-kind tranfers for soical housing can be approximated by the difference between the rent paid and the market value of the housing. The difficulty lies in assessing the value of housing on the private market also called *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 one is a hedonic method based on regression. The value of the rent is estimated based on the characteristics of the dwelling and its occupants. However, unobservable differences in dwelling quality between homeowners, nonmarket tenants and market tenants can be observed: to correct this biais the Heckman method is used (Heckman, 1979). We could also used another approach: the Self-Assessment Approach. The latter consists of asking owner-occupiers and nonmarket tenants what the value of the rent they estimate for their housing if it were put on the market. However, as we can see in figure 6, the data show a rather large difference between observed rents and imputed rents with the self-assessment approach for Luxembourg. Moreover, households tend to evaluate the value of their rent using rounded values and not precise values, which explains the presence of local maxima around rounded values such as 1500, 2000, 2500. Self-asses rents therefore do not seem to be a good criterion, at least in Luxembourg, for estimating the value of housing on the private market. Concerning the rents imputed by the Heckman method, we observe a distribution that is close to that of the observed rents. [5] It is normal that the two distributions do not totally overlap because homeowners and nonmarket tenants dwellings may have characteristics that differ from those of market tenants. In addition, since imputed rents are obtained using a model, there is also a certain margin of error

[5]The rent value imputed by the Heckman method is available directly in the database because it is calculated by STATEC, the Luxembourgish national statistical office.

between the imputed rent and the rent that would actually be observed if the housing were actually put on the private market.

Finally, we chose to approach the value of in-kind transfers for social housing by measuring the difference between the imputed rent and the rent actually paid by a household residing in a social housing.

Figure 6: Observed, imputed and subjective rent in EUROMOD



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

2.4 Equivalence scale

One of the key issue when including in-kind transfers in income inequality analysis is to use the appropriate equivalence scale. Traditional scales (OECD-modified equivalence scale or the square root of household size) are suitable for assessing cash transfers. They make it possible to take into account the economies of scale represented by living together. Thus, a household composed of a couple does not need twice as many resources to achieve the same well-being as a single individual. Indeed, many expenses are shared when several people live together. The equivalence scale captures differences in needs and enables to compare heterogeneous households. While traditional scales seem adequate for cash needs, 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 overestimate the income and well-being of those who use public services. This is what Radner (1997) calls the *consistency problem*. For instance, a person in poor health have greater recourse to health care and would therefore be considered better off than a person in good health if needs are not taken into account.

But this transfer is necessary to equalize the well-being of a healthy person and an unhealthy person. In addition, economies of scale are generally absent from public services (visit a dentist by one husehold member will not diminish another member's dental care needs). Two main alternatives to traditional equivalence scales have been proposed in the literature: Paulus et al. (2010) and Aaberge et al. (2010).

Paulus et al. (2010) proposed 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 measure 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. Thus, the "extended" equivalence scale must 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:

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

With y the household's disposable income, k the household's need for publics services (approximated by the monetary value of public services) and e the OECD modified equivalence scale.

Aaberge et al. (2010) have proposed a theoretical framework for a better consideration of needs for public services in equivalence scales. The individual equivalence scale for non-cash income (NC) is measured by the ratio between the minimum needs in public services for the individual belonging to group j (women aged 50 to 54, for example) and the minimum needs for individuals in reference group r (single men aged 35 to 39, for example). The minimum needs per group are measurable using local public expenditure data. The need-adjusted equivalence scale (NA) is the weighted sum of the equivalence scale for disposable cash income (CI) and the equivalence scale for non-cash income (NC). Thus, the adjusted equivalence scale (NA) for household h is expressed as follows :

$$NA_h = \theta_r CI_h + (1-\theta_r) \sum_j n_{hj} NC_j \tag{6}$$

with θ_r the weight assigned to cash income for the reference group r. CI_h the equivalence scale for disposable income of household h, NC_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 local data, which is not easily accesible for all countries. Thus, Aaberge et al. (2017) also proposed an alternative method to the minimum needs to calculate NC_j. This alternative is based on subgroup averages rather than minimum needs. They also calculated a Simplified Needs-Adjusted equivalence scale (SNA) in order to obtain an adjusted equivalence scale identical to all European countries and simple to use. In this paper, we also use the average approach using data from Luxembourg. Then, we estimate NC_j by the ratio between the average amount of in-kind transfers received by group j and the average amount of in-kind trans-

fers received by the reference group r.[6] The groups are based on age groups (5 years), education levels currently being attended and gender. The reference group is composed of males aged between 35 and 39 who are not in education. In addition, we use the OECD-modified equivalence scale for household disposable cash-income CI_h. Finally, like 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. The equivalence scale measured with Luxemburgish data is called "needs-ajusted Luxembourg scale".

To evaluate the importance of needs-adjusted scale and the sensitivity of the results we calculate, in section 3, inequality indicators using the OECD-modified scale, the simplidied-needs ajusted scale (SNA) from Aaberge et al. (2017) and the needs-ajusted Luxembourg scale. The table 3 illustrates the value of the different equivalence scales for certain types of households.

Table 3: Comparison of equivalence scales

Gender	Age	Education	OECD Modified Scale	Simplified Needs-ajusted Scale*	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
Couple	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
Couple +	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

*The Simplified Needs-Ajusted Scale comes from Aaberge et al. (2017).

This section has described the methods used in this investigation and has shown that a more comprehensive measure of income leads to methodological challenges. First, because income survey data contain little or no information on consumption and on the use of public services. The second challenge is the *consistency problem*: in-kind needs must be taken into account in the equivalence scale used to compare household well-being. In the

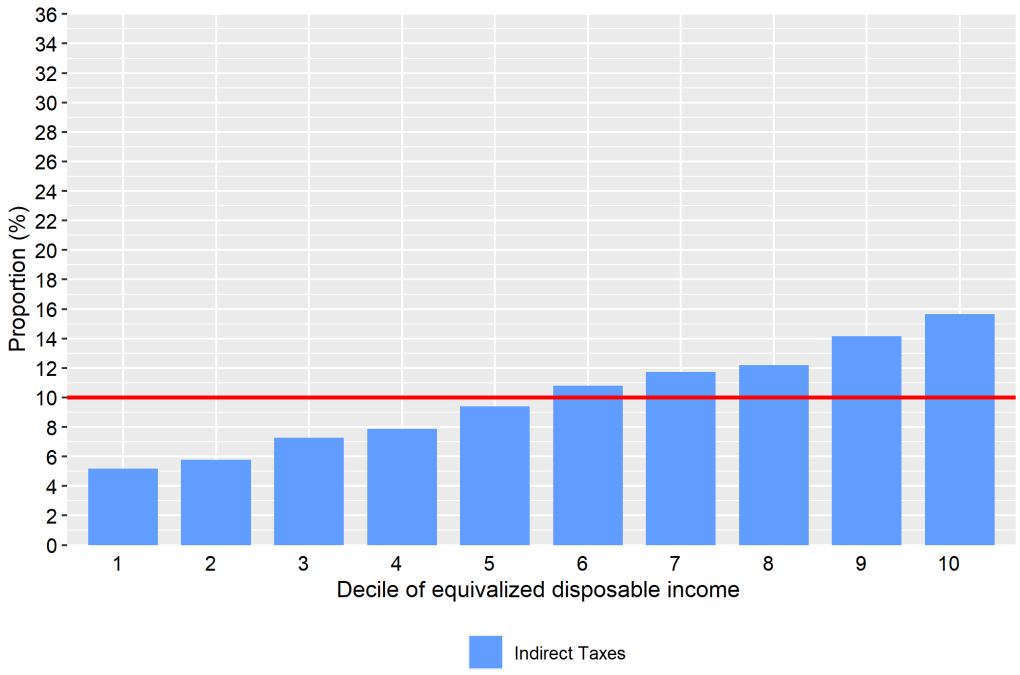
[6]This approach assumes that expenditures per capita for a group correctly reflects the public services needs of a group.

next section, we present the main findings of the current investigation.

3 Results

First, we present the results concerning the distribution of indirect taxes by decile of equivalized disposable income in figure 7. The share of indirect taxes paid by the richest 10% represents more than 15% of indirect taxes collected from resident households against around 5% for the poorest 10%. This is because richer household consume more in absolute terms. However, this figure only shows the distribution of the total amounts distributed by deciles; it does not give us information on whether or not the indirect taxes are progressive, since this figure does not expresses indirect taxes in proportion of income. Thus, although one household pays more indirect taxes than another one, this does not necessarily mean that the tax burden in proportion of income is higher for the first household.

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

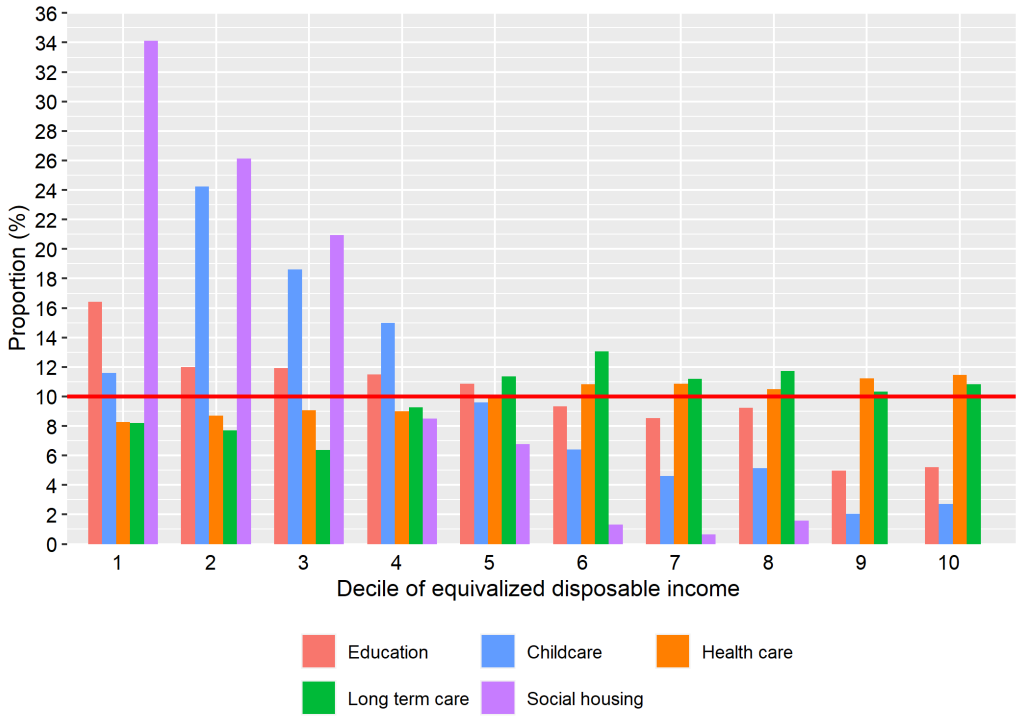


Note: deciles are constructed using equivalized disposable income (OECD-modified scale) of the household; each decile includes the same number of individuals.
Source: EUROMOD + data based on EU-SILC (2016). The disposable income of EUROMOD data is simulated using the 2018 socio-fiscal system and expenditures are imputed using Engel curves. Authors' calculations.

If we now turn to the distribution of total in-kind tranfers distributed by decile (cf. figure 8) we observe, as Paulus et al. (2010) did for some countries, that educational in-kind transfers are more strongly concentrated in the first deciles (16% of total in-kind transfers for education are received by the poorest 10%, compared to less than 10% in deciles 6 to 10, in Luxembourg). This results can be explained by the greater presence of households

with children in the first deciles of equivalized disposable income. The concentration in the first deciles is even more important for child care. As with education, there are more households with children in the first deciles, and since the child care in-kind transfer is means-tested, this increases the concentration of total transfers in bottom deciles. On the other hand, total transfers for health and long-term care seems more equitably distributed among the income distribution. However, the share is somewhat higher in the high deciles due to the greater presence of older people receiving more health and long-term care. In-kind transfers from social housing are highly concentrated in the first deciles, but we still observed that some households in high deciles receive some part of the in-kind transfer for social-housing. This can be explain by the fact that even if the economic situation of the household has improve, the social tenant is not forced to leave the dwelling. As for indirect taxes, figure 8 highlights which deciles receive more in-kind transfers, in absolute terms, but does not indicate the share of these transfers as a proportion of household income. This last point is important to know how these transfers affect household income and inequality.

Figure 8: Agregate 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.

Table 4 decomposes the household income by equivalized disposable income decile. This decomposition is expressed in percentage of the average household disposable income of the decile. Therefore, we measure the share of each tax-benefit component as a proportion of the average disposable income for each decile. The 10% of individuals with the highest cash standard of living belong to households with an original income (capital

income, market income, private transfers) higher than the disposable income (original income represents 118.1% of disposable income). The value of the cash transfers received by these households does not compensate for the direct taxes paid by these households. By comparison, in all other deciles, the average household original income is lower than the average household disposable income of the decile. Overall, the average household original income in the total population corresponds to 89.3% of the average disposable income. Thus, the "direct" part of the tax-benefit system (cash benefits, direct taxes, social insurance contributions) increase household income by an average of 10.7%.

When public pensions are taken into account, the gross income of households (original income + public pensions) in deciles 4 to 10 is higher than the average disposable income of the decile. We can also notice that public pensions represent a larger share of disposable income in the highest deciles. This is explained by the generosity of the Luxembourgish pension system, which allows pensioners to be in relatively high deciles.

Social benefits, whether means-tested or not, represent a larger share of disposable income for poorer households. Cash benefits represent only 2.0% of disposable income in decile 10 compared to 45.7% in decile 1. However, differences between deciles is less important when considering non means-tested social benefits. To the contrary of benefits, the tax burden (including social security contributions and income tax) is higher for the richest households. The progressiveness of the tax burden is, however, greater for income tax compared to social insurance contributions. In fact, we observe that income tax has even a small positive impact on household disposable income in decile 1 which is related to tax credit.

Table 4: Household income composition by source and decile of equivalized disposable income, percentage of household disposable income

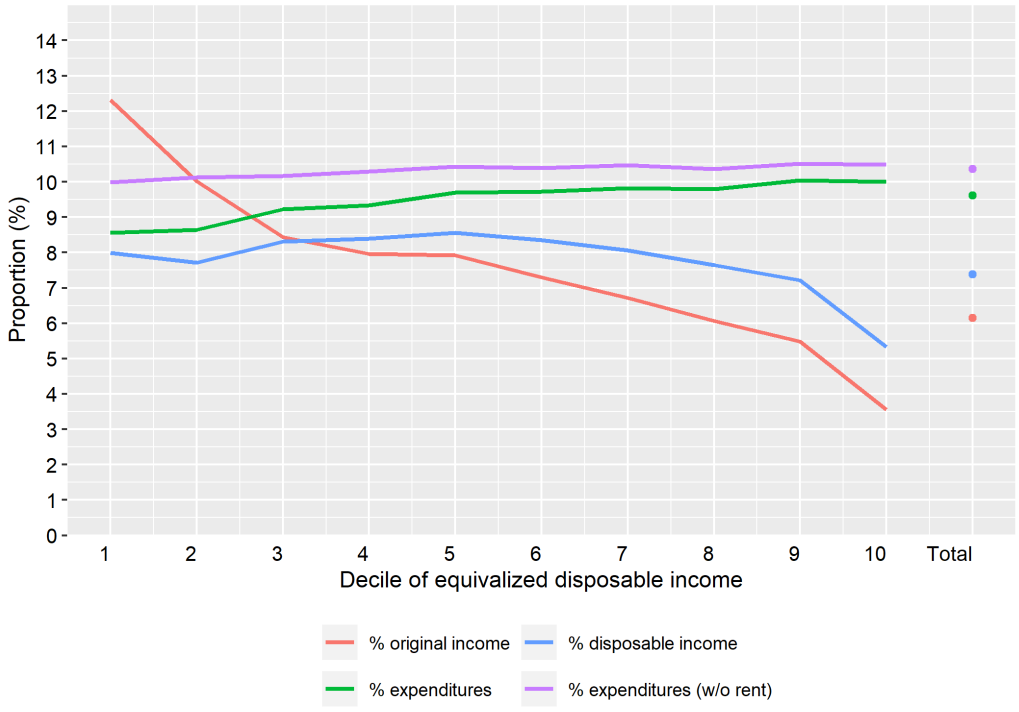
	Decile										
	1	2	3	4	5	6	7	8	9	10	Total
Original Income	56.3	58.5	71.6	80.3	75.4	80.5	82.5	95.7	94.4	118.1	89.3
Public pensions	6.9	15.2	23.7	23.2	30.2	32.6	37.0	30.4	36.7	31.6	29.6
Nonmeans-tested benefits	15.0	14.1	11.1	9.2	9.1	6.8	4.7	4.2	2.8	1.9	6.1
Means tested benefits	30.7	21.4	6.1	2.9	2.8	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 child care	3.8	6.8	4.5	3.4	1.8	1.0	0.7	0.7	0.2	0.2	1.6
In-kind health care	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.
Notes: deciles are constructed using the equivalized disposable income (modified OECD scale) of the household; each decile includes the same number of individuals.

The incidence of indirect taxes in proportion of disposable income is higher in the bottom compare to the top of the income distribution (table 4). Households in deciles 8,

9 and 10 have a lower tax burden related to indirect taxes (7.6% of disposable income or less) than those in the other deciles (between 7.7% and 8.6%). Thus, even if richer households pay more indirect taxes in absolute terms (cf. figure 7), the tax burden of indirect taxes is lower for these households. Figure 9 gives us a sharper look at indirect taxes. It shows the incidence of indirect taxation (VAT and excise duties) on 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 original income to disposable income (after direct taxes and social transfers) limits the regressivity of indirect taxes but it still present. On the other hand, when considering the impact of indirect taxation according to expenditures or consumption (that can be seen as a proxy for permanent income), it can see that the tax is slightly progressive, with richer households devoting a larger proportion of their expenditures to pay indirect taxes. This slight progressivity is mainly due to the presence of reduced VAT rates or VAT exemptions which benefit more to the poorest households. However, if we eliminate actual rent expenditures, on which no indirect taxes are levied on, we notice that the progressivity with consumption is much less strong. This result may be explained by the fact that renting an accommodation concern mainly poorer households, the others being more often homeowners. It is therefore mainly the fact that a larger part of the budget is devoted to rent for poorer household that is responsible for the progressivity of indirect taxes with consumption.

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.

Finally, in-kind transfers increase the average household income by 31.7% with strong heterogenity across decile (cf. table 4). The increase is about 83.0% in decile 1 but reach 11.5% in the last decile. The increase in income generated by taking public services into account is consistent with the results of Verbist et al. (2012), which show that the same 5 public services in 27 OECD countries account for 76% of disposable income in the first quintile compared with 14% in the last quintile (data of 2007). Similarly, Paulus et al. (2010) observe that adding in-kind transfers for education, social housing and health care would increase household disposable income from 18% to 27% depending on the country considered (5 European countries are included in their study). The decomposition by quintile gives an increase between 54 and 67% in the first quintile and between 8% and 13% in the last quintile depending on the country.

As Verbist et al. (2012), we find that education-related and health-related in-kind transfers appear to account for a much larger share of total household disposable income. Education and health care represent respectively 15.5 and 11.8% of average disposable income in Luxembourg against 1.6 and 2.8% respectively for child care and long term care in the overall population. The degressive trend in share of in-kind transfers (in proportion of disposable income) with income level can be observed for all public services taken into account (except the 2nd decile for child care). Thus, health-related transfers increase household disposable income from 6.2% in decile 10 to 20.3% in decile 1 and education from 3.7% in decile 10 against 53.3% in decile 1. Health-related transfers increase more the disposable income than education-related income only for deciles 9 and 10. Child care-related transfers increase more disposable income of poorer households and has almost no effect in the top deciles (increase income by 0.2% in deciles 9 and 10). Long-term care has a limited effect on disposable income with an increase of income which is less than 5%, regardless of the position of the household in the income distribution. Finally, social housing has a very small effect on income of both poor and rich households. This is explained by the very low share of social housing in the total housing stock in Luxembourg. All in all, our results show that taking into account only cash transfers and direct taxes gives only a partial view of the resources available to households. On average among resident households, extended income is 26% higher than disposable income. The underestimation of resources by the measure of disposable income is all the more important as the household has a low cash standard of living. This underestimation of income, particularly for the less well-off, is likely to impact income inequality in the country, which is what we will analyze later.

As shown in table 5, comparing household income composition by household type is also very informative. We distinguish between people living alone and aged under 65 years old and those who also live alone but are 65 years old or older. We also consider couples living alone (without children or other adults in the household). Finally, we also focus on single-parent households where at least one of the children is under 18 years old and couples with at least one child under 18 years of age. The remaining 25% 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, original income accounts for only 11.7% per cent of the average disposable income of singles aged 65 or more. On the other hand, pensions represent more

Table 5: Household income composition by source and type of household, percentage of disposable income

	Household type					
	Single <65 y.o.	Single >64 y.o.	Couple w/o child <65 y.o. <65 y.o.	Couple w/o child (at least 1 >64 y.o.)	Single parent (at least 1 child < 18)	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
Nonmeans-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 child care	0.0	0.0	0.0	0.0	5.7	4.0
In-kind health care	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.
Notes: deciles are constructed using the equivalized disposable income (modified OECD scale) of the household; each decile includes the same number of individuals.

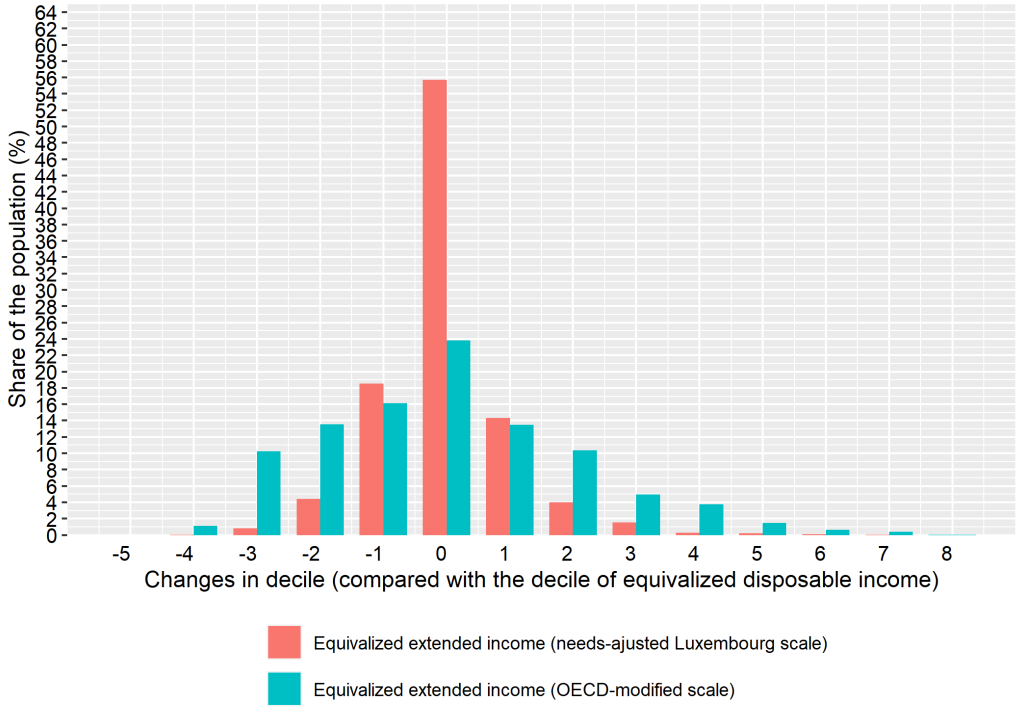
than 100% of disposable income for households with a single person over 64 years of age or a couple where one of whom is over 64 years of age: this is the main source of income for people aged 65 and over. Other social cash transfers appear to be a more important source of income for lone-parent families (30.4% of the average disposable income of these households compared to 8.8% for people living alone and under 65 years of age). Social insurance contributions correspond to a more important proportion of households income for household including working age person and income tax represents a lower share of household income for single-parent families compared to other type of households.

Indirect taxes reduce the disposable income of all households, but to a somewhat lesser extent for single and old households. With regard to in-kind transfers for education, they strongly increase the income of households with children, especially single-parent families. The same is true for child care 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 (increase in average household income of about 20% compared to less than 11% for other categories of households). Similarly, long-term care in-kind tranfers increase the income of households composed of elderly people by 9 to 14% compared with less than 1% 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. Finally, in-kind transfers represent about 10% of disposable income for households under 65 years old,

without children, between 30 and 35% of disposable income for elderly households, about 50% for couples with children and more than 75% for single-parent families.

Since we have estimated the extended income, we can measure the equivalent extended income. By classifying individuals by decile, we can notice 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 (equivalized with the OECD-modified scale). We note that only 24% of individuals do not change their position in the income distribution and that some individuals experience very large decile variations (-5, +8). As explained in section 2.4, the use of an equivalence scale that does not take into account the needs for public services overestimate 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% 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.

Figure 10: Comparison of decile of equivalized disposable income with decile of equivalized extended income



Note: 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 expenditure is imputed using Engel curves. Authors' calculations.

Table 6 shows the evolution of inequality according to each component of the Luxembourgish tax-benefit system. We used the OECD-modified equivalence scale for the cash components and the Luxembourgish needs-ajusted equivalence scale for the non-cash components. We compare the results with those observed if other equivalence scales

are used (OECD-modified scale and Simplified Needs-Adjusted scale). We choose two inequality indicators: the relative Gini coefficient to measure relative inequality and the absolute Gini coefficient to measure the absolute level of inequality.

We observe a sharp decline in inequality after taking into account cash benefits and direct taxes (disposable income) with a reduction of 49.9% of the relative Gini and 45.3% of the absolute Gini. The public pensions, the cash social benefits and the income tax reduce strongly the relative inequality on the Luxembourgish population while it is mainly income tax that reduce absolute inequality. Indirect taxes additionally increase relative inequality by 2.5 percent but decrease the absolute inequality by 5.1%. The latter is decreasing because better-off households pay more indirect taxes in absolute terms and thus the income gap between rich and poor decrease. However, the less well-off households lose a larger proportion of their income after indirect taxes: the relative Gini increases. The negative impact of indirect taxes on relative inequality is also found by Figari and Paulus (2015) with an increase in the relative Gini coefficient of between 3% and 10% for the three countries studied.

The inclusion of in-kind transfers allow a further reduction in the relative Gini coefficient compared to disposable income after indirect taxes from 23% to 26% depending on the scale of equivalence used. The effect on relative inequality thus seems less important than the effect of social benefits and directes taxes. Concerning absolute inequality, social in-kind transfers increase inequality by 5.2% (in comparison to inequality of disposable income post indirect taxes) if the OECD-modified scale is used, compared with a decrease of 18 to 25% if scales that adjust for public service needs are used. As explained earlier, the absence of adjustments for public service needs overestimates the equivalent income of certain categories of the population, leading to an increase in 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.

Focusing on the results obtained with the "needs-adjusted Luxembourg" scale (which are relatively 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 (relative Gini drop of 24.7%) and reduce absolute differences in income between individuals in the population (absolute Gini drop of 18.2%). It is mainly education and health services that reduce relative inequality (decrease of 12.4% and 9.5% respectively with 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 inequalities because, according to the insurance approach and after correcting for differences in needs, all individuals receive a very similar amount. All in all, the Luxembourgish tax-benefits system allows to reduce relative inequality of 61.3% and the absolute inequality of 57.5%.[7]

[7]The same conclusion emerge using alternative indicators of income inequality such as the inter-decile ratio (D9/D1) and the inter-decile difference (D9-D1).

Table 6: Changes in relative and absolute Gini coefficient for each component of the Luxembourgish tax-benefit system

	Relative Gini			Absolute Gini		
	OECD-modified	Simplified Needs-adjusted*	Luxembourg Needs-adjusted	OECD-modified	Simplified Needs-adjusted*	Luxembourg Needs-adjusted
Original income	**0.479**			**1387.1**		
+Public pensions	0.363			1351.3		
Variation(%) wrt original income	-24.2			-3.4		
+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 child care	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 health care	0.189	0.185	0.189	745.2	607.7	591.1
Variation(%) wrt child care	-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 health care	-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**	**-24.7**	**-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. * The Simplified Needs-Adjusted scale come from Aaberge et al. (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.

4 Discussion and conclusion

This article analyses a more comprehensive definition of income for the case of Luxembourg. It allows a deeper analysis of the distributive impact of the Luxembourgish tax-benefit system. We use the extended income measure already in use in other studies (Figari and Paulus, 2015). This measure is based on disposable income where we subtract indirect taxes paid by household and we add the in-kind transfers received. 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 households. As taxes are deducted from disposable income, it seems important to include the counterpart of these taxes (among others the public services) to get a more accurate picture of the resources available to households.

Using imputation and simulation methods developed in the economic literature and using survey data, we simulated the indirect taxes paid by households resident in Luxembourg and estimated a monetary value for the public services they receive. We estimated

that indirect taxes and in-kind transfers represent respectively 7.4% and 31.7% 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 more strongly the income of the least well-off households. It is particularly in-kind transfers related to education and health care that increase household income. Similarly, households with elderly or households with children benefit more from in-kind transfers (health care and long term care for elderly and education-related in-kind transfers for families with children).

After adjusting for the needs of public services, we have shown that Luxembourgish tax-benefit system reduces the relative inequality by 61.3% and the absolute inequality by 57.4%. It therefore allows for a significant reduction in income inequality. Although a large part of this reduction is attributable to the "direct" part of the tax-benefit system (direct taxes, cash social transfers, social insurance contributions), in-kind transfers make it possible to achieve greater equalization of household income. On the other hand, indirect taxes slightly increase relative inequality, because the tax burden related to indirect taxes is higher among poor 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, direct and indirect taxes) in order to have a better idea of the efficiency and the generosity of the tax-benefit system in Luxembourg. Focusing only 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. But it is important to keep in mind that non-cash income has very different characteristics from cash income. The latter allow 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 the non-cash incomes are fictitious incomes that are intended for the consumption of specific goods and services. The presence of public services and other in-kind benefits helps households to meet some needs such as health and education that they would have had to pay by 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 measure of extended income is therefore complementary to the measure of disposable income.

In addition, imputation of in-kind transfers are based on strong assumptions and the present analysis is a short-term analysis. Today's poor households may become tomorrow's rich households. Also, from a life-cycle perspective, it is possible that, at the end, in-kind transfers benefit more to better-off households. This issue should be further explored in future research. Similarly, one aspect is still neglected in this paper: the wealth. The lack of data in this field has not allowed us to introduce it. However, wealth could also modify somewhat the picture of income inequality in Luxembourg.

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