INCOME DISTRIBUTION AND INEQUALITY IN LUXEMBOURG AND THE NEIGHBOURING COUNTRIES, 1995-2013

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We use two sources of dataset to assess the changes in the income distribution in Luxembourg from 1995 to 2013. Income data for 2004 and 2013 are from the EU-SILC survey while data for 1995 are from the ECHP. The sample is composed of individuals aged 16 and above and its size changes over time: 7,602 individuals in 2004, 8,005 in 2013 and 1,968 in 1995. The income variable for each individual is computed from the yearly disposable household income.** Total disposable household income is the sum of personal employee and self-employed income, income components at the household level (income from rental of a property or land, family/children related allowances, housing allowances, capital income and other transfers and revenues) minus employer's social insurance contributions and taxes on income and wealth. In order to take into account the size of the household and economies of scale of living together, income is equivalized dividing total household income by the square root of household size, assuming that household income is shared equally among the household members. The final income variable used in the analyses is expressed in real terms by correcting for inflation using the Indice des Prix à la Consommation National (IPCN, base year 2005).

Table 1 contains some summary statistics for the three years considered. We observe on average an increase of about 20 percent in real income as compared to 1995, with the increase being higher in the bottom part of the income distribution (5th percentile) than in the upper part (95th percentile). However, the rise in average and median incomes has been mainly produced in the first of the two periods considered, namely from 1995 to 2004. In the last decade, from 2004 to 2013, average and median income have remained almost stable (showing only a very modest increase).

Inequality is measured with two indices: the Gini index and the Theil index. This latter may be less easily interpretable than the Gini index but it has the advantage of being additively decomposable by subgroups of the population, which allow us to explore the contribution to inequality by different groups such as males and females, as we will discuss later. Both indexes show an initial decrease in inequality in Luxembourg from 1995 to 2004, followed by a strong increase from 2004 to 2013. This increase in inequality suggests that, despite the fact that average and median incomes have remained almost the same in 2004 and 2013, the differences in income between individuals have enlarged.

One question is where this increase in inequality comes from, and whether some particular subgroup of the population has contributed more to the increase in inequality. This issue will be explored in the next section. The last index we show in Table 1 is the Wolfson index of polarization, which is constructed from the Gini index.*** Income polarization differs from income inequality in the sense that while inequality measures differences in incomes, polarization is an indication of the clustering of the population around the middle income level. The Wolfson index lies between 0 and 1 with higher values indicating a more polarized society. Minimum polarization corresponds to minimum inequality and it is attained when all individuals have the same level of income. Maximum inequality differs from maximum polarization: maximum inequality is reached when one individual possesses the total income and all the others zero; the maximum level of polarization occurs when half the population has zero income and the other half all the rest. We can see from Table 1 that both inequality and polarization in Luxembourg decreased from 1995 to 2004; and increased from 2004 to 2013.

Table 1 – Summary statistics for Luxembourg

	1995	2004	2013
Mean	30 797	36 451	36 981
Median	26 628	32 541	32 649
5th percentile	11 988	13 800	14 347
95th percentile	62 023	70 230	71 976
Gini inequality index	0,289	0,258	0,296
Theil inequality index	0,148	0,115	0,174
Wolfson polarization index	0,234	0,221	0,232

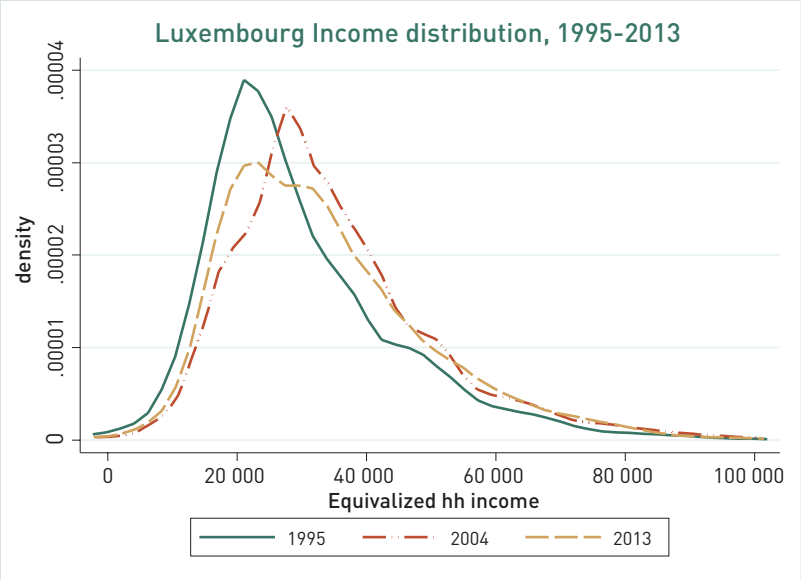
* *The authors are extremely grateful to the CSL for discussion and thoughtful comments.*

** *Income values for 1995 are converted to euro by using the exchange rate of 40.3399.*

*** *Wolfson index= [2(2T-Gini)]/[(median income/mean income)], where T=0.5-L(0.5), with L(0.5) denoting the income share of the bottom half of the population.*

Figure 1 shows the distribution of income in Luxembourg in the three years, non-parametrically estimated via an adaptive kernel. The figure is truncated at value 100000 euros for clarity of illustration. We observe a change in the shape of the distribution over time, with a shift of the density from the middle towards the two tails of the distribution, both right and left. Also, from 1995 to 2004 the distribution has moved towards the right, depicting the increase in average income during this period; in 2013, the distribution is still at the right of the 1995 curve, but not at the right of 2004 and its shape has extensively changed. The income distribution in 2013 shows two peaks in the middle which were not so clearly present in 1995 or 2004, and it has become more spread. It seems evident that this is due to the loss in income faced by the middle class: the mass both at the right and at the left of the median (which increased only of 108 euros from 2004 to 2013) moved towards lower levels of income. The density of 2013 appears to be a mixture of the densities of the previous two years and the two peaks are reminiscent of the modes of the other two densities: the first the mode of 1995, the second that of 2004 shifted slightly to the right. This suggests that the increase in inequality registered by Gini and Theil is due to a transformation of the middle class which is splitting in two groups (those that were able to keep the benefits gained from 1995 to 2004 and those, the large majority, who went back to income levels more similar to those of 1995), ending up in a greater distance between high and low income individuals.

Figure 1 – Income distribution in Luxembourg in 1995, 2004 and 2013



I. Decomposition of inequality by subgroups of population

We are interested in understanding where the change in income inequality comes from and whether some groups of the population experienced more beneficial changes in income than others. The similarity or differences between these changes can be interpreted with another concept of polarization. The polarization captured by the index of Wolfson we analysed before concerned only clustering of the population around the middle of the income distribution without any information on who belonged to those clusters. Now, we include in the analysis additional information on the characteristics of the population. If inequality is caused for example by low educated individuals becoming poorer on average and high educated individuals becoming on average richer, we would observe not only an increase in total inequality, but also an increase in polarization with two clusters of the population becoming more polarized and hence moving away from each-other in terms of average incomes accruing to those groups.

But total inequality and polarization do not necessarily move in the same direction. Going back to the previous example, if we observe an increase in inequality among low educated individuals (or/and among high educated individuals), total inequality would increase but polarization would decrease since the two clusters would become more similar in terms of income possessed. In other words, it would be harder to associate poor individual to low education since we would observe also many more high educated individuals in poverty. Similarly for richness. For this purpose, we can decompose the Theil inequality index according to some characteristics of the population, and explore whether there has been an increase not only in overall inequality in the population, but also in the distance between the average income of the groups. This section explores the pattern of inequality and polarization considering four characteristics of the individuals: gender, education, age and occupational skills.

II. Gender

Table 2 shows the change in average income for males and females. Both groups have experienced an increase in their income between 1995 and 2004, while over the last decade average income has remained almost unchanged, with only males experiencing a slight increase.

Table 2 – Average income by gender

	1995	2004	2013	Change 1995-2013	Change 2004-2013
Males	31 654	36 495	37 053	17,1 %	1,5 %
Females	30 517	35 246	35 127	15,1 %	-0,3 %

In order to calculate the contribution to total inequality by males and females and the degree of polarization between these two groups, we use the Theil index which can be decomposed into two components: a between-group component, which measures the level of inequality between the average income possessed by males and by females, and a within-group component, which assesses inequality within each group. The sum of between- and within-group inequality gives the total Theil index.

Table 3 shows that for all the years within group inequality is much higher than between group inequality, which is almost zero. This suggests that in Luxembourg there is no noticeable difference in the average income possessed by males and females, but a large inequality among females and among males within their respective groups. Inequality within groups follows the same pattern of inequality present in the total population, with an initial decrease from 1995 to 2004 followed by an increase until 2013. However, looking at the contribution to total inequality by the two groups, we see that inequality among males has increased more in the last decade than inequality among females. Using the two components of Theil index, we can calculate the degree of polarization between males and females through the index described before which was actually proposed by Zhang and Kanbur (2008). This index is the ratio of between-group inequality and within-group inequality for the reasons explained above. This index captures the average distance between groups (between-group component of the Theil index) in relation to the spread of the distributions within groups (within-group component). As we can notice from Table 3, the level of polarization between males and females is almost zero, but it has increased from 2004 to 2013 ("ZK polarization").

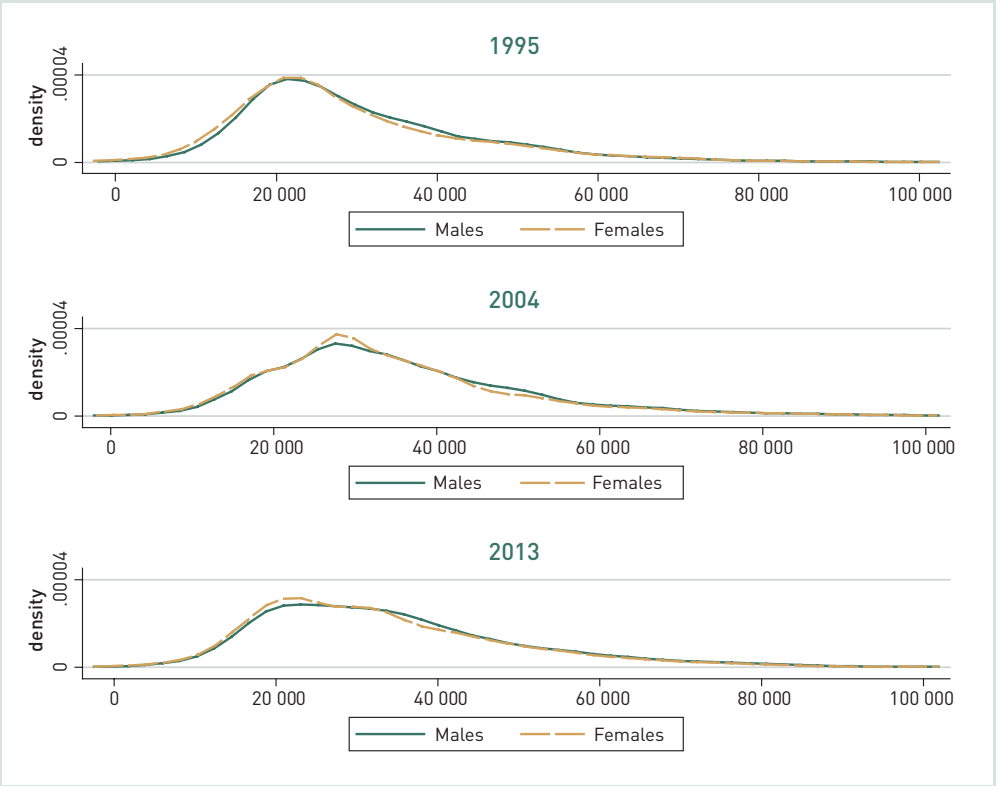
Table 3 – Theil decomposition by gender

	Between group inequality	Within group inequality	Theil index	ZK polarisation	Contribution to total inequality	
					males	females
1995	0,000	0,148	0,148	0,001	48,5 %	51,4 %
2004	0,000	0,115	0,115	0,001	49,3 %	50,6 %
2013	0,000	0,173	0,174	0,002	54,3 %	45,5 %

Graphically, Figure 2 shows the income distribution for males and females in the three years considered. The income distributions of males and females overlay in all years, with the one for males being slightly more towards to the right, suggesting only a small difference in income between males and females. The figure thus tells two facts: over the last twenty years Luxembourg did not suffer from a significant gender gap in terms of equivalized household income as described above; both males and females have experienced an increase in inequality in the last decade due to a transformation in the respective middle classes. We observe a change in the shape of the income distributions over time. In particular, for both

groups the figure displays a movement from the middle to the two tails of the distribution from 2004 to 2013, and more so towards lower levels of income. The middle class of both groups experienced a loss in income, as already reported above for the entire population. The partition among men and women allows understanding that there were more the women who were not able to keep the benefits gained from 1995 to 2004 moving back to income levels more similar to those of 1995.

Figure 2 – Income distribution by year and by gender



III. Educational level

We repeat a similar decomposition analysis using a different characteristic of the population, namely educational level. We divide the population in three subgroups according to whether the individual has completed only primary or less than secondary education (43 percent of the total population), secondary (36 percent) or university or post-secondary degree (21 percent). Table 4 shows the changes in average income for the three groups and years. In all periods we observe a big difference in income between high- and low-educated individuals. Moreover, while average income has increased over time for all the groups from 1995 to 2004, in the last period only medium educated individuals have seen their income increase, while lowest educated individuals have experienced a large drop in their average income.

Table 4 – Average income by educational level

	1995	2004	2013	Change 1995-2013	Change 2004-2013
Primary	25 727	30 552	28 278	9,9 %	-7,4 %
Secondary	33 230	35 640	36 887	11,0 %	3,5 %
University degree	47 405	49 278	48 666	2,7 %	-1,2 %

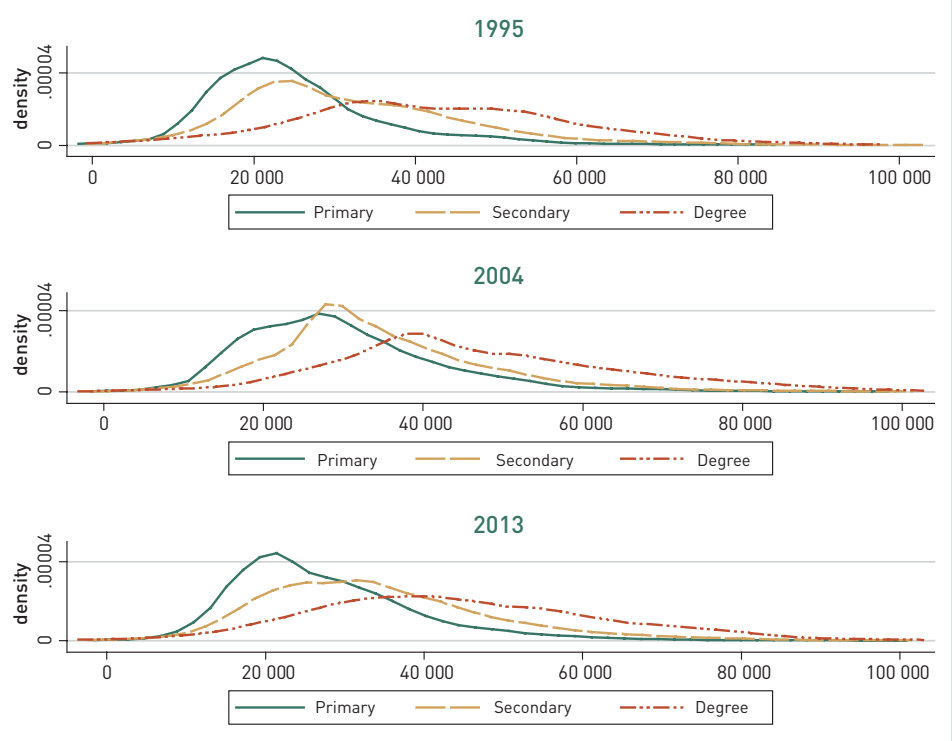
We again explore the pattern of inequality and polarization decomposing the Theil index into the between- and within-group components (Table 5). As above for males and females, dividing the population according to the educational level allows observing that total inequality is caused much more by within-group than between-group inequality. Both between and within inequality decreased from 1995 to 2004 and increased from 2004 to 2013. While between-group inequality did not reach the level of 1995, within-group inequality has increased a great deal. The contribution to total inequality has also changed over time: in 1995 and 2004 the group of lowest educated individuals was that contributing the most to inequality; in 2013 medium-educated people are those contributing the most to inequality, while inequality from low-educated individuals has largely decreased. In terms of polarization, we observe a much higher degree of polarization in the society according to education than to gender. Yet, polarization between high and low educated individuals has decreased over time due to the increase in within group inequality.

Table 5 – Theil decomposition by education

	Between group inequality	Within group inequality	Theil index	ZK polarisation	Contribution to total inequality		
					Primary	Secondary	Degree
1995	0,027	0,124	0,152	0,218	34,4 %	23,8 %	23,9 %
2004	0,017	0,097	0,114	0,173	33,6 %	30,3 %	21,4 %
2013	0,023	0,151	0,174	0,150	19,9 %	38,1 %	28,9 %

The distribution of income by educational level and year is displayed in Figure 3. The three groups differ in the average level of income, with the distribution of income of the individuals with a degree being located more to the right of the income scale. For all the groups there has been a change in the shape of the distribution over time. Low-educated individuals, whose income curve is the one more to the left due to their lower mean income, seem to have experienced a slight increase in the income dispersion from 1995 to 2004, but in 2013 the curve it is more centred to the middle, which is in line with the large decrease in contribution to total inequality from the low-educated individuals discussed above (see Table 5). For those with secondary or degree education, there has been instead a movement towards the tails over time, especially for the medium-educated individuals, whose contribution to total inequality has continuously increased over time. For people holding a degree, there has been an initial reduction in the dispersion in their income distribution from 1995 to 2004, but then again the curve has become more spread towards the tails in 2013. The middle classes experiencing a loss in income are those of low and medium educated individuals. It is to these two groups that the changes reported above for the entire population can be attributed: it is mainly them who were not able to keep the benefits gained from 1995 to 2004 moving back to income levels more similar to those of 1995.

Figure 3 – Income distribution by year and education



IV. Age

Another characteristic which we use to explore the change in inequality is individuals' age. We divide the population in four groups: below age 30, 30 to 44, 45 to 64 and above 65. Table 6 shows that average income increases in age up to retirement. Above age 65, we observe however a difference in the income pattern over the three periods. While in 1995 and 2004 average income decreased after retirement, in 2013 we observe a continuous increase in age with almost no difference between the average income of those in working age and those in their retirement age. Indeed, the oldest group is that experiencing the largest increase in average income over time, while middle-aged individuals and the youngest cohort have seen their average income decrease in real terms in the last decade.

Table 6 – Average income by age group

	1995	2004	2013	Change 1995-2013	Change 2004-2013
< 30	31 090	34 755	34 126	9,8 %	-1,8 %
30-44	31 893	35 037	35 252	10,5 %	0,6 %
45-64	32 476	39 171	37 493	15,4 %	-4,3 %
≥ 65	27 045	32 581	37 073	37,1 %	13,8 %

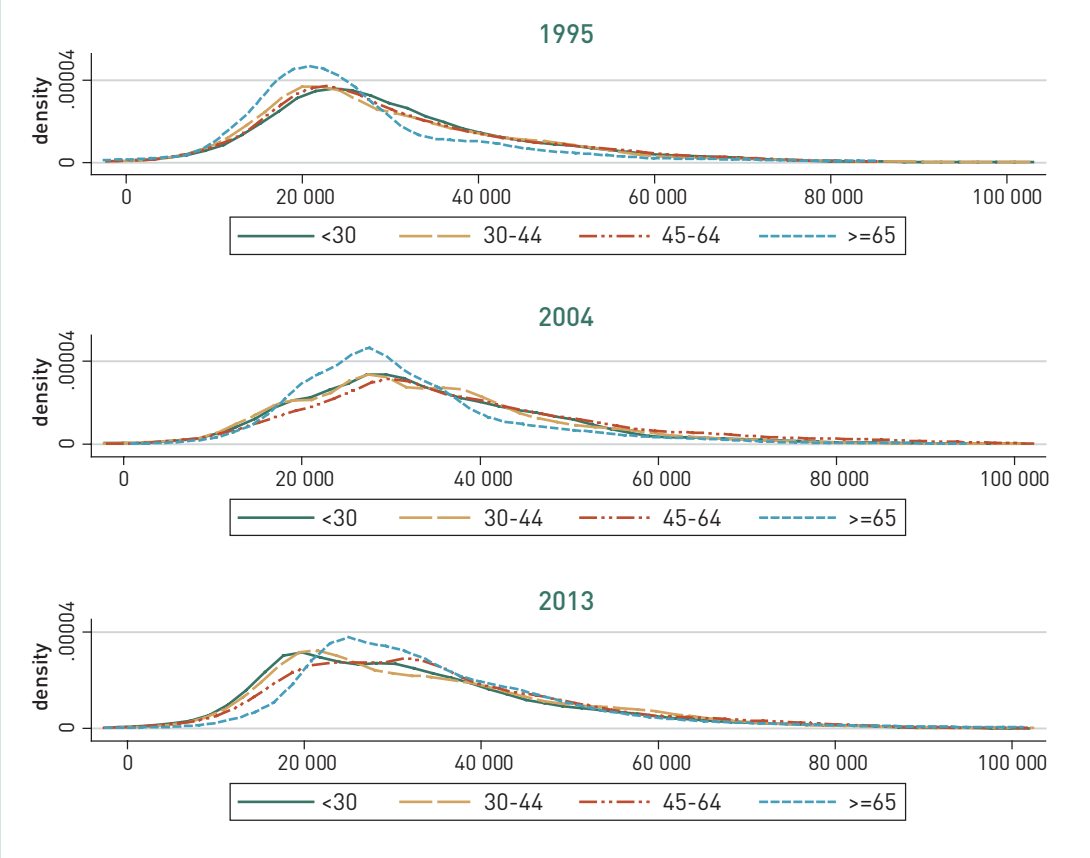
In terms of decomposition of inequality (Table 7), within-group inequality contributes more to total inequality than between-group inequality. Also, within-group inequality has first decreased in the years 1995-2004 and then increased from 2004 to 2013, with the latter year being more unequal than the former. Polarization is very low here, and it is decreasing as compared to 1995, again due to an increase in inequality within age groups. Inequality from the middle-aged individuals is the one that contributes the most in percentage terms to total inequality in all periods. However, while the percentages are more similar in the years 1995 and 2004, in 2013 the contribution to total inequality comes mainly from those in the age group 45-64. The lowest share of inequality comes from the oldest cohort, but their contribution has increased from 1995 to 2013.

Table 7 – Theil decomposition by age group

	Between group inequality	Within group inequality	Theil index	ZK polarisation	Contribution to total inequality			
					< 30	30-44	45-64	≥ 65
1995	0,002	0,147	0,148	0,013	15,3 %	35,2 %	33,9 %	14,3 %
2004	0,002	0,112	0,115	0,020	18,1 %	31,1 %	35,3 %	13,5 %
2013	0,001	0,173	0,174	0,004	20,2 %	25,5 %	36,7 %	17,2 %

Figure 4 contains the income distribution by age groups and year. The most noticeable fact is that the income curve of the oldest cohort (above age 65) has largely moved towards the right in 2013, as also witnessed above by the relevant increase in average income for this group. This overall gain in income is not present in any of the other age groups. For the other three age cohorts, in 1995 the curves were quite overlapping and of similar shape, but in 2004 and especially 2013 the distributions are moving apart from each other and there has been also a clear change in their shapes. Overall, all the age groups have experienced an increase in the spread of the distribution from 2004 to 2013, indicating an increase in inequality within each age group; with the exception of the oldest group, they have moved to the left, especially those below 45. It is the middle classes of these age groups experiencing the greatest loss in income from 2004 to 2013.

Figure 4 – Income distribution by year and age group



V. Occupational Skills

The last decomposition considers the occupational skills. We use the ISCO-88 occupation codes to classify the individuals in four groups according to their level of skills. High-skilled occupations are thus defined as those involving managerial, professional or associate professional positions; semi-skilled workers as clerks, service and sales workers; skilled manual workers as those working in agriculture, craft industry, machineries having skilled or semi-skilled occupations; unskilled workers are those having an occupation classified as elementary occupation in the ISCO-88 codes, such as labourers in agriculture, mining and construction, domestic helpers and cleaners. Table 8 shows the average income by occupational skills for the three periods considered. Average income is, as expected, decreasing in the level of occupational skills, with high-skilled workers having in all periods almost a double level of average income compared to unskilled workers. We observe again a very different pattern from 1995 to 2004 and from 2004 to 2013. In the first period unskilled and skilled manual workers are the categories whose average income had increased the most, while in the last decade the opposite occurred. Individuals working in unskilled occupations are those whose income has dropped the most during the recent crisis, while income of high-skill workers has remained relatively stable.

Table 8 – Average income by occupational skills

	1995	2004	2013	Variation 1995-2013	Variation 2004-2013
High-skilled workers	45 967	45 847	46 488	1,1 %	1,4 %
Semi-skilled workers	34 168	33 015	32 647	-4,5 %	-1,1 %
Skilled manual workers	25 947	29 243	28 532	10,0 %	-2,4 %
Unskilled workers	22 541	26 599	24 447	8,5 %	-8,1 %

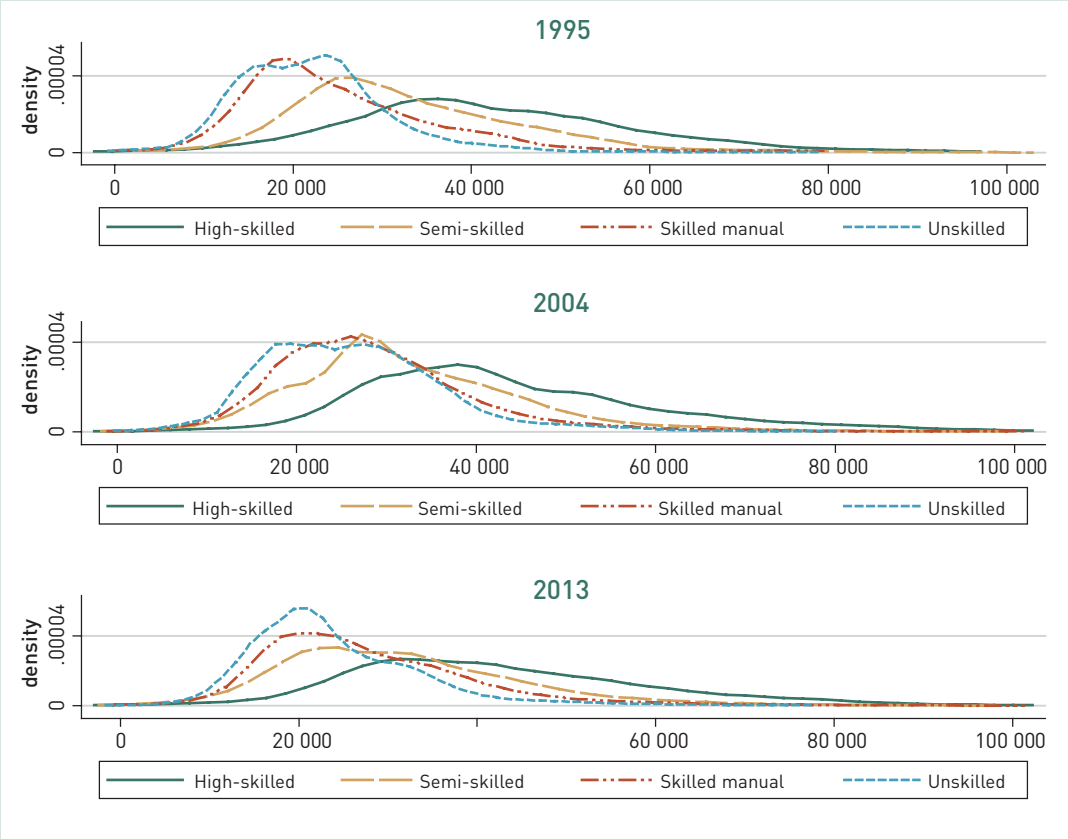
The decomposition of the Theil index and polarization is displayed in Table 9. Similarly to what we found for the previous groups, we observe a higher level of inequality within-group than between-group, and both have increased from 2004 to 2013. The distribution of occupational skills are much more polarised than those of gender and age due to a higher level of between group inequality. In all periods the highest contribution to total inequality is from high-skilled workers, while manual and unskilled workers contribute the least to overall inequality. Also, the contribution to total inequality from high skilled workers has increased over time, while that from manual and unskilled workers remained almost unchanged, and even decreased in the last decade.

Table 9 – Theil decomposition by occupational skills

	Between group inequality	Within group inequality	Theil index	ZK polarisation	Contribution to total inequality			
					High-skilled	Semi-skilled	Skilled manual	Unskilled
1995	0,033	0,114	0,114	0,287	40,3 %	21,3 %	11,4 %	4,6 %
2004	0,023	0,091	0,091	0,254	38,6 %	19,2 %	15,1 %	6,8 %
2013	0,028	0,141	0,169	0,202	45,8 %	21,7 %	11,2 %	4,6 %

Finally, Figure 5 shows graphically the distribution of income by occupational skill groups and year. The four distributions are centred in different points of the income scale, as to be expected from the higher value of between group inequality, with low-skilled occupations being at the left of the scale and high-skilled at the right. This is true in all periods. In terms of the shape, the distribution of high-skilled is the one that differs the most from the others, being much more spread in all periods. This is in line with the evidence from Table 9 showing that the high-skilled workers contribute the most to total inequality. From 2004 to 2013, the distribution of semi-skilled workers has become more spread out, while that of unskilled worker displays also a higher density in the middle of the distribution in 2013 than in 2004 and 1995, suggesting that inequality within this group has decreased over time. Also, the income curve of the unskilled workers has slightly shifted to the left, indicating an impoverishment of this group in the last period considered.

Figure 5 – Income distribution by year and occupational skills



VI. Some comparisons with the neighbouring countries

We compare some of the results from Luxembourg reported above with the figures for the neighbouring countries. We use the same datasets, namely ECHP for 1995 and EU-SILC for 2004 and 2013, to analyse the income distribution in France, Belgium and Germany. For this latter however, since EU-SILC data is not available for 2004, and we rely on the German Socio-Economic Panel (SOEP) for this year. Income is, as before, equivalized disposable household income expressed in euros* and in real terms using the Harmonized Consumer Price Index for the neighbouring countries and the IPCN for Luxembourg.

Table 10 contains the summary statistics for Luxembourg and those for Belgium, France and Germany. The four countries experienced an increase in average income over the last twenty years, but the increase has been larger in the first period than from 2004 to 2013, except for Belgium where the increase in average income is larger in the second period. During the recent crisis, Germany is the country performing the worst in terms of mean and median income changes, followed by Luxembourg. Belgium and France have instead experienced a large increase in their average income in the last period. In terms of inequality, the country which has experienced the largest increase in inequality is Germany, as measured both by Gini and Theil indexes, followed by Luxembourg. Inequality in Belgium has decreased from 1995 and it has remained almost the same during the years 2004 and 2013, while in France it has increased. Despite the increase in inequality in Luxembourg, the Gini index in 2013 is similar to the level of France and Germany, while Belgium has the lowest level. In terms of income polarization, the four countries are overall very similar, but in France and Belgium polarization has slightly decreased over time.

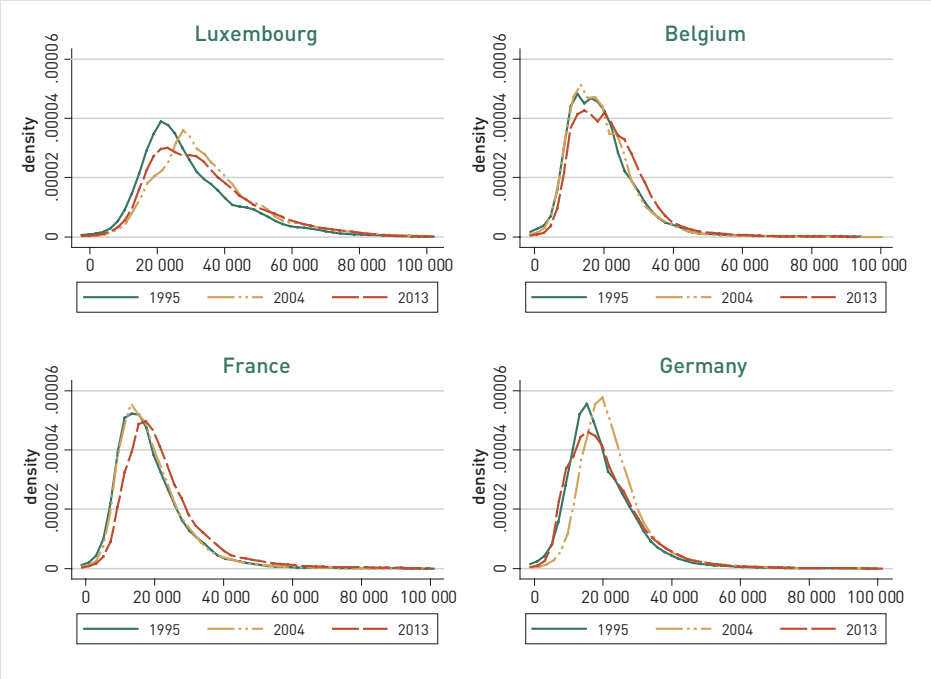
Table 10 – Summary statistics for Luxembourg and the neighbouring countries

	Luxembourg			Belgium			France			Germany		
	1995	2004	2013	1995	2004	2013	1995	2004	2013	1995	2004	2013
Mean	30 797	36 451	36 981	20 297	19 120	21 662	18 892	20 112	23 993	20 237	25 468	21 764
Median	26 628	32 541	32 649	18 081	17 498	19 880	16 548	17 463	20 434	17 920	22 664	19 164
Gini inequality index	0,289	0,258	0,296	0,303	0,267	0,265	0,292	0,287	0,306	0,284	0,229	0,301
Theil inequality index	0,148	0,115	0,174	0,196	0,123	0,125	0,153	0,157	0,195	0,145	0,093	0,175
Wolfson polarization index	0,234	0,221	0,232	0,226	0,228	0,224	0,239	0,231	0,220	0,226	0,202	0,228

Graphically, Figure 6 compares the income distributions of the four countries in the three years. We see clearly the movement to the right of the French and Belgium distributions in 2013, as average income has increased in these countries. In Luxembourg and Germany we observe more differences in the shapes of the distribution over the periods; in both countries there has been a movement towards the right from 1995 to 2004 due to the large increase in average income in this period, but in 2013 the curve has become more spread out and in Germany has moved back to the left close to the 1995 distribution while in Luxembourg the change in its shape is more evident.

* *The exchange rates used to convert national currency in euros in 1995 are: 40.3399 for Belgium, 6.55957 for France and 1.95583 for Germany.*

Figure 6 – Income distribution in Luxembourg and the neighbouring countries



VII. Conclusions

After a period of economic growth and decrease of inequality from 1995 to 2004, during the years of the great recession average income has remained almost unchanged in Luxembourg, while inequality has increased. The groups that contributed most to total inequality are individuals aged 45-64, with secondary education and high-skills. Contribution to inequality is fairly split between males and females but the latter lost on average more from 2004 to 2013. For all the individual characteristics, namely gender, age, educational level and occupational skills, inequality appears much higher within groups than between groups, and the level of polarization is almost zero when we consider characteristics such as age and gender, but higher according to educational level and occupation skills. Contrary to what happened for inequality, polarization has decreased over time for all the groups and remained almost unchanged for the overall population due to an increase in within group inequality. In terms of real income changes, lowest educated individuals and unskilled workers are the categories most hit by the crisis, as their average income has fallen from 2004 to 2013. The only individuals who have experienced a large increase in real average income in the recent years are those aged 65 and above.

Comparing the situation with that of the neighbouring countries, we see that the crisis has been even worse for Germany, where income on average has largely decreased from 2004 to 2013 and inequality increased. Belgium and France appears instead performing better both in terms of changes in average income and income inequality. The level of inequality and polarization is however pretty similar across the four countries, with Belgium being the most equal. In terms of real income however average income in Luxembourg is still the highest among the four countries.