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HOUSEHOLD INDEBTEDNESS AND THEIR VULNERABILITY TO RISING INTEREST RATES

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Household indebtedness and their vulnerability to rising interest rates♣

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Abstract

High inflation and rising interest rates could increase financial vulnerability among Luxembourg households, who tend to carry significant debt. This paper uses micro-data on individual households from the Luxembourg Household Finance and Consumption Survey (HFCS) to identify pockets of financial vulnerability across the resident population. We calculate seven standard debt burden indicators and simulate their evolution through the end of 2023 based on BCL macroeconomic projections. According to several indicators, the share of financially vulnerable households increased from 2018 to 2021. Our simulations suggest this trend continued in 2022 and 2023 for those indicators that focus on the risk of delayed payment, although it may have reverted for other indicators that focus on the level of debt. Risk is concentrated among low-income households, but indebted households in this group only account for 11% of the number of mortgage contracts and 9% of aggregate household sector debt.

JEL-codes: E44, E47, G21, G28, G51

Keywords: Household debt; Financial vulnerability; Interest rates; Micro-simulation

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Non-technical summary

The current context of high inflation and rising interest rates could increase financial vulnerability among Luxembourg households, who tend to carry significant debt. If shocks persist for long, the economic outlook could deteriorate and risks to financial stability could increase.

This paper uses micro-data on individual households from the Luxembourg Household Finance and Consumption Survey (HFCS), including the last wave conducted at the end of 2021, to identify pockets of financial vulnerability across the resident population. We calculate several debt burden indicators for each household and use them to estimate the share of households that is financially vulnerable. Seven indicators are analysed: the debt-to-income ratio, the debt-to-assets ratio and the loan-to-value ratio, the debt service-to-income ratio, the mortgage debt service-to-income ratio, the probability of default and the ratio of net liquid assets to income.

Since the end of 2021, the macroeconomic situation has changed substantially, triggering an increase in interest rates. To reflect these changes, we use Luxembourg HFCS data from the 2021 wave to simulate several components of individual household cash flows and balance sheets for the years 2022 and 2023, using the BCL macroeconomic projections of December 2022. To account for the uncertainty surrounding the projections, we run a sensitivity analysis that evaluates the robustness of our results.

According to several indicators, the share of financially vulnerable households in Luxembourg increased from 2018 to 2021. In particular, the debt-to-income ratio deteriorated as household debt grew faster than income. Our simulations suggest that in 2022 and 2023 debt service rose faster than income and that the probability of default also increased on average. However, the debt-to-assets ratio and the loan-to-value ratio remained stable between 2018 and 2021, as household debt and real estate values increased at similar rates, and the simulations suggest a mild improvement in 2022 and 2023. Finally, the ratio of net liquid assets to income improved slightly between 2018 and 2021 and simulations suggest a mild deterioration in 2022 and 2023.

Looking across the income distribution, credit risk is concentrated among low-income households. However, according to the HFCS the 20% of households with the lowest income only represent 9% of aggregate household sector debt and 11% of the number of mortgage contracts in Luxembourg, limiting the possible impact on private consumption and aggregate economic activity.

Résumé non-technique

Le contexte actuel de forte inflation et de hausses des taux d'intérêt pourrait accroître la vulnérabilité financière des ménages luxembourgeois, qui sont en général très endettés. Si les chocs persistent longtemps, les perspectives économiques pourraient se détériorer et les risques pour la stabilité financière pourraient augmenter.

Cet article utilise des micro-données sur les ménages individuels de l'enquête luxembourgeoise sur les finances et la consommation des ménages (HFCS), y compris la dernière vague menée fin 2021, pour identifier les poches de vulnérabilité financière au sein de la population résidente. Nous calculons plusieurs indicateurs de charge de la dette pour chaque ménage et les utilisons pour estimer la part des ménages financièrement vulnérables. Sept indicateurs sont analysés : le ratio dette/revenu, le ratio dette/actif et le ratio prêt/valeur, le ratio service de la dette/revenu, le ratio service de la dette hypothécaire/revenu, la probabilité de défaut et le ratio actifs liquides nets/revenu.

Depuis la fin de 2021, la situation macroéconomique a considérablement changé, déclenchant des hausses des taux d'intérêt. Pour refléter ces changements, nous utilisons les données HFCS de la vague 2021 pour simuler plusieurs composantes des flux financiers et des bilans des ménages individuels pour les années 2022 et 2023 en utilisant les projections macroéconomiques de la BCL de décembre 2022. Pour tenir compte de la l'incertitude entourant les projections, nous avons effectué une analyse de sensibilité qui évalue la robustesse de nos résultats.

Selon plusieurs indicateurs, la part des ménages financièrement vulnérables au Luxembourg a augmenté entre 2018 et 2021. Notamment, le ratio dette/revenu s'est détérioré, car l'endettement des ménages a augmenté plus rapidement que leur revenu. Nos simulations suggèrent qu'en 2022 et 2023 le service de la dette a augmenté plus rapidement que le revenu et que la probabilité de défaut a aussi augmenté en moyenne. Cependant, le ratio dette/actif et le ratio prêt/valeur sont restés stables entre 2018 et 2021, la dette et la valeur de l'immobilier ayant augmenté à peu près au même rythme. Selon nos simulations, cette évolution aurait tendance à s'inverser légèrement en 2022 et 2023. Enfin, le ratio liquidités nettes/revenu s'est légèrement amélioré entre 2018 et 2021, bien que les simulations suggèrent une légère détérioration en 2022 et 2023.

En examinant la situation financière des ménages selon le niveau des revenus, le risque de crédit se trouve concentré parmi les ménages plus modestes. Cependant, selon les données de l'enquête HFCS, les 20 % des ménages aux revenus les plus modestes ne représentent que 9 % de la dette totale du secteur des ménages et 11 % du nombre de contrats hypothécaires au Luxembourg, ce qui limite l'éventuel impact sur la consommation privée et l'activité économique agrégée.

1. Introduction

Households accumulating high levels of debt relative to their disposable income or wealth can indicate financial vulnerability. The current context of high inflation and rising interest rates could increase the vulnerability of Luxembourg households, who tend to carry significant debt. In the short term, rising consumer prices and interest rates reduce the income remaining for saving or non-essential consumption. Some households may even need to borrow to finance consumption and the most vulnerable could default on their loan obligations. If financial stress is prolonged, the economic outlook could deteriorate and risks to financial stability could increase.

Policymakers closely monitor the evolution of household debt in Luxembourg. Each year, the BCL Financial Stability Review analyses the debt burden of households to evaluate their financial vulnerability.[1] These assessments systematically warned that the household sector was substantially indebted and could potentially be vulnerable to interest rate increases. The ECB Financial Stability Review also stressed that in recent years many households benefited from resilience factors such as excess savings, labour market strength, supportive fiscal policy and longer interest rate fixation periods, which may soon end (ECB, 2022).

Figure 1 illustrates the growing indebtedness of the Luxembourg household sector, based on the October 2022 national accounts release. The ratio of household sector debt to disposable income was 75% in 1995, but 180% in 2021, with a marked rise since 2002 (Figure 1, left scale). Mortgage debt in particular rose from 47% of disposable income in 1999 to 148% in 2021. As in other countries, mortgage debt is the main component of household debt. Its share increased from 57% of aggregate household sector debt in 1999 to 82% in 2021. In part, these changes reflect the persistent increase in residential real estate prices in Luxembourg.[2] Apart from mortgage debt, household debt includes consumer loans, other loans[3] and loans to residents from non-resident banks. Overall, these categories of loans grew at a rate similar to that of household disposable income, so they did not contribute to the dramatic increase in the debt-to-disposable income ratio. These components accounted for 43% of aggregate household sector debt in 1999, but only 18% in 2021.

Households also hold financial assets that they could potentially sell to repay debt in the event of a negative shock to their disposable income. In Figure 1, the blue line at the top reports the ratio of aggregate household sector debt to the value of these financial assets. On the right hand scale, this ratio increased from 32% in 1999 to 40% in 2021. The limited increase in this ratio is reassuring, at least at the aggregate level. Clearly, households' financial assets grew faster than their disposable income, which explains the different evolutions of the two curves.

However, macro-economic data provide only a partial view of the situation, which can differ dramatically across households. Therefore, this paper also analyses individual household data from the Luxembourg Household Finance and Consumption Survey (HFCS), including the last wave conducted at the end of 2021. By analysing the situation of individual households, it is possible to identify pockets of vulnerability resulting from differences in the distributions of income, assets and debt across the population. In other words, the same level of aggregate debt in the household sector may generate different levels of risk, depending on how debt is distributed across the population, since individual financial situations vary considerably.

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1 See Box 1.3 in BCL (2022), p. 35-37.

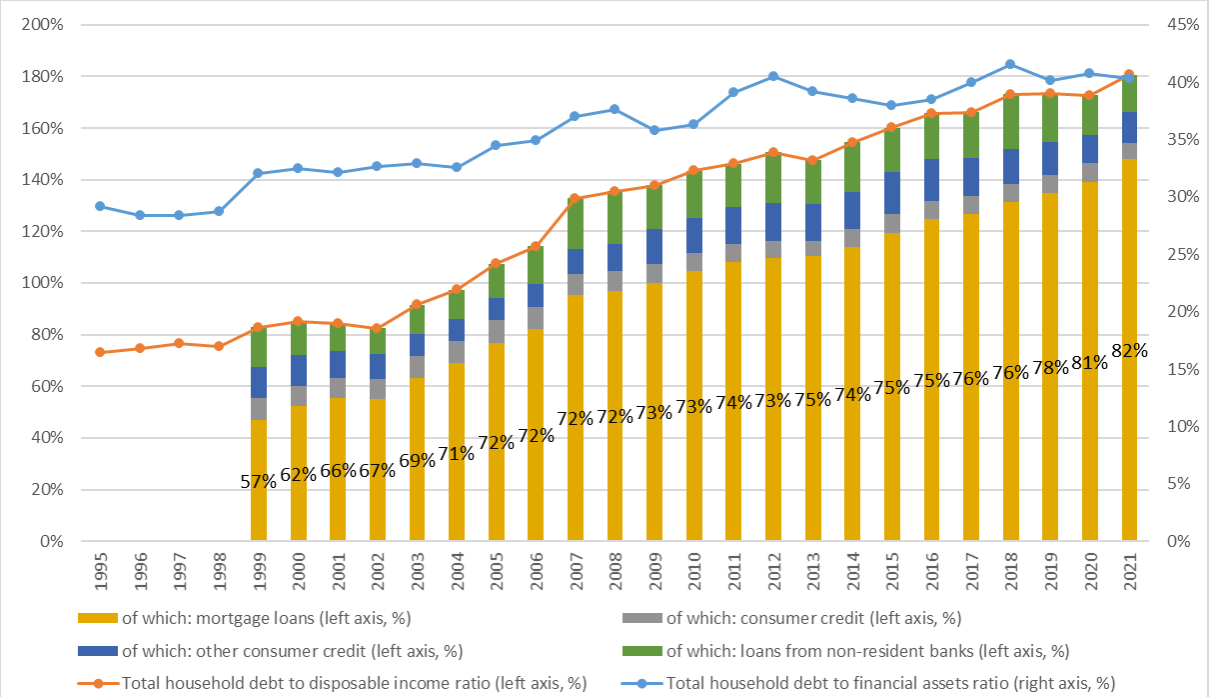
2 See Section 3 of Chapter 1 (p. 21-45, especially page 36) in BCL (2022). See also Reinesch (2022).

3 These are credits granted for professional reasons, for the consolidation of debts, for financing education, etc.

Finally, to update results from when the data was collected in 2021, this paper conducts a micro-simulation of household balance sheets in 2022 and 2023, following standard practice in central banks and the IMF (Valderrama et al., 2023; Banco de Portugal, 2022; Dieckelmann and Metzler, 2022; Morell et al., 2022; Reserve Bank of Australia, 2022). For instance, Banco de Portugal (2022) combine information from different surveys (HFCS, the EU Survey on Income and Living Conditions and the EU Labour Force Survey) to assess the impact of inflation and the rise in interest rates on households´ financial situation by quintile of the income distribution. The Reserve Bank of Australia (2022) performs a similar analysis focused on indebted households. Dieckelmann and Metzler (2022) project household financial distress in the short run using standard financial vulnerability ratios. In a more general study, Valderrama et al. (2023) design alternative scenarios to analyse short-run effects on households' financial situation and consumption in several European countries.

This paper is organized as follows. Section 2 describes the Luxembourg HFCS dataset, defines the indicators calculated and the assumptions underlying our simulation. Section 3 reports household debt burden and financial vulnerability indicators for the years 2010, 2014, 2018 and 2021, as well as the simulated years 2022 and 2023. In section 4, we report the share of financially vulnerable households by income quintile. In section 5, we conduct a sensitivity analysis before we conclude in section 6.

Figure 1 : Debt-to-(disposable)-income ratio and debt-to-financial-assets ratio (%)



Sources: STATEC and BCL. Aggregate household sector debt is drawn from Statistical Table 05.08 and its breakdown from Table 11.07 on www.bcl.lu. Gross disposable income (B.6b) and financial assets are drawn from STATEC national accounts, in particular the complete sequence of household sector accounts (S.14+S.15).
Notes: Percentages in the yellow bars indicate the share of mortgage debt in aggregate household sector debt.

2. Data and methodology

Using HFCS data, we calculate several debt burden indicators at the level of individual households, such as the debt-to-income ratio or the debt-to-assets ratio, which we then use to estimate the share of households that are "financially vulnerable" (Giordana and Ziegelmeyer, 2017). Table 1 defines the different indicators, specifying the conventional threshold for each indicator above which households are considered financially vulnerable. Seven indicators are analysed, including the debt-to-income ratio, the debt-to- assets ratio and the loan-to-value ratio, which measure the level of household indebtedness, as well as the debt service-to-income ratio, the mortgage debt service-to-income ratio and the probability of default, which measure the risk of accumulating late payments. Finally, the ratio of net liquid assets to income measures the household's ability to absorb negative shocks to its disposable income.

Table 1: Household debt burden indicators and conventional financial vulnerability thresholds

Debt burden indicator	Definition	Vulnerability threshold
Outstanding loan-to-value ratio of household main residence (LTV) - stock	Outstanding stock of mortgages on the household main residence (HMR) divided by the current value of the HMR. Only defined for households with HMR mortgage debt.	≥ 75%
Debt-to-assets ratio (DA)	Total outstanding debt divided by household assets.	≥ 75%
Debt-to-income ratio (DI)	Total outstanding debt divided by annual household gross income.	≥ 3
Debt service-to-income ratio (DSI)	Monthly debt payments divided by monthly gross income. Excludes credit lines/overdraft liabilities for which the HFCS collects no information on debt service. [(a)]	≥ 40%
Mortgage debt service-to-income ratio (MDSI)	Total monthly mortgage debt payments (mortgages on the HMR and other properties) divided by household gross monthly income. Only defined for households with mortgage debt.	≥ 40%
Probability of default (PD)	A function of the household's monthly financial margin and its level of liquid assets. The financial margin includes gross household income minus taxes, social security contributions, rent, regular debt service payments, and an estimate of basic living costs.[(b)]	≥ 0

Complementary indicator	Definition	Threshold
Net liquid assets to income ratio (NLAI)	Net liquid assets divided by gross annual income. Net liquid assets include deposits, mutual funds, debt securities, business wealth (except for self-employment), publicly traded shares and managed accounts, minus credit line/overdraft debt, credit card debt and other non-mortgage debt.	< 2 months of income

Notes: [(a)] Debt service includes interest and principal repayment but excludes taxes, insurance and any other related fees. Payments for leasing contracts are also excluded.

[(b)] The probability of default is zero if the household has a positive financial margin or sufficient liquid assets to cover its negative financial margin for at least three months (matching the conventional 90-day limit used to define non-performing loans). Otherwise, the probability of default is a simple linear function of the ratio of the negative financial margin (in absolute value) to liquid assets.

We use micro-data from the four waves of the Luxembourg HFCS collected in 2010, 2014, 2018 and 2021.[4] Due to the pandemic, the survey mode changed in 2021, abandoning in-person interviews and moving online, which led to a drop in the response rate.[5] Therefore, comparisons across waves are subject to this caveat.

To assess the impact of recent developments on household financial vulnerability, we use data from the 2021 wave to simulate the evolution of individual household debt, assets, income and expenditures for the years 2022 and 2023. Table 2 presents the macroeconomic assumptions underlying these micro-simulations. In particular, we use the BCL December 2022 macroeconomic projections (part II in BCL (2023)) to adapt income, expenditure (food, energy, monthly debt service[6] and other), real and financial assets, and household debt, so that household balance sheets match the evolution of the economic environment. The micro-simulations assume that the population of indebted households in 2022 and 2023 share the same demographic and socio-economic characteristics as the population of indebted households observed in 2021. The micro-simulations also take into account the impact on households of budgetary policies included in the Energiedësch package (February 2022), as well as the most important measures of Solidaritéitspak 1.0 (March 2022) and 2.0 (September 2022).[7]

Table 2: Assumptions underlying the simulations of the balance sheet of indebted resident households in 2022 and 2023 (annual rate of change, unless otherwise indicated, in %)

	2021	2022	2023
Harmonized consumption price index [(a)]	3.5	8.2	2.3
National consumption price index [(a)]	2.5	6.4	3.4
National consumption price index - energy [(a)]	18.9	31.1	-7.1
Compensation per employee [(a)]	6.0	4.5	6.5
Eurostoxx index [(a)]	24.4	-7.4	1.5
Euro area 10-year bond yield (% p.a.)[(a)]	0.1	1.8	2.6
Lending rate on consumer credit (% p.a.)[(b)]	4.5	4.8	6.4
Lending rate on mortgage loans (% p.a.) [(b)]	1.3	2.4	3.7

Source: [(a)] BCL macroeconomic projections, December 2022 exercise (BCL, 2023); [(b)] Expert views and own calculations.
Notes: The projections take into account the outcome of negotiations between social partners.

4 The first wave, carried out mainly in 2010, surveyed 950 households. The second wave, conducted in 2014, interviewed 1,601 households. The third wave, conducted in 2018, interviewed 1,616 households and the fourth wave, conducted in 2021, interviewed 2,010 households. Individual responses are weighted to represent the entire population.

5 The advantages and disadvantages of the change in survey mode and its implications for the results will be discussed in more detail in the Luxembourg HFCS technical report on the fourth wave (in preparation).

6 To adjust the amount of debt service, we assume that on average 40% of mortgages are at fixed rates. The remaining part of the debt is affected by the rise in interest rates. We also assume that each year 25% of households indebted for the purchase of real estate are subject to the new borrowing conditions.

7 The simulations take into account the following measures of the Energiedësch package (renewed in 2023 by the Solidaritéit 2.0 package): the energy bonus for low-income households, the stabilization of electricity prices and the subsidy of gas network costs. From the Solidaritéit 1.0 package, the simulations for 2022 take into account the introduction of the energy tax credit, the freezing of rents, the adaptation of the rent subsidy, and the reduction of 7.5 cents per litre of diesel and fuel. The Solidaritéit 2.0 package renews some of the previous measures in 2023. In addition, the simulations take into account the limitation of the increase in gas prices to 15% and the temporary reduction in the VAT rate (normal, intermediate and reduced rates) by one percentage point.

3. Evolution of household debt burden and financial vulnerability

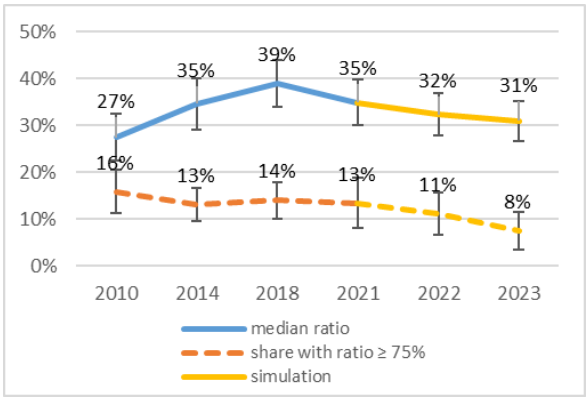
The simulations target the population of resident households in Luxembourg that were indebted in previous years. This share decreased from 58% of the household population in 2010, to 55% in 2014, to 53% in 2018 and 54% in 2021.

For each debt burden indicator defined in Table 1, the following figures present its median level across indebted households[8] and the shares of these households that are "financially vulnerable" for the years 2010, 2014, 2018 and 2021 (HFCS waves) and for the years 2022 and 2023 (micro-simulations). For observations before 2022, the right panel of each figure shows the empirical cumulative distribution of the debt burden indicator in question.

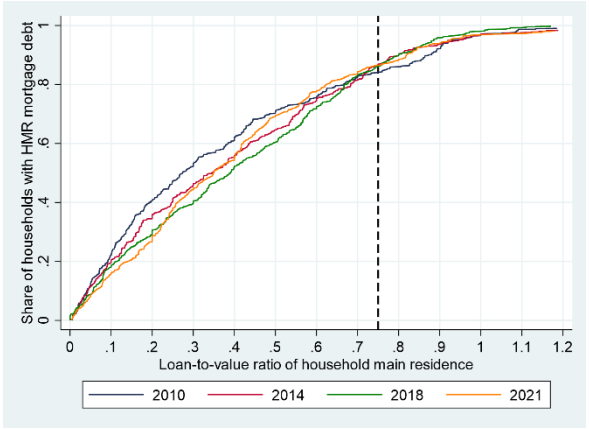
Unless otherwise stated, the standard deviations and confidence intervals presented below take into account both the uncertainty associated with sampling variability and the multiple imputation procedure used to replace missing data.[9] For 2022 to 2023, the confidence intervals do not take into account the uncertainty associated with the projections. Differences between years are statistically significant when confidence intervals do not overlap.

Figure 2: Loan-to-value ratio of household main residence by year

a) Median ratio and share of financially vulnerable households



b) Cumulative distribution by survey year



Source: Own calculations based on wave 1 to 4 of the LU-HFCS; data are multiply imputed and weighted. Error bars indicate the 95% confidence interval.
Panel (b): cumulative distribution functions are calculated across all 5 implicates each year. The vertical line indicates the conventional limit. We omit the long upper tail of the cumulative distribution functions.

For the loan-to-value ratio (Figure 2) and the debt-to-asset ratio (Figure 3), median values did not change significantly between 2014 and 2021. According to these indicators, the share of financially vulnerable households (those whose ratios exceed conventional limits) was also stable. Comparing different waves, the cumulative distributions (panel b of Figure 2 and Figure 3) are similar around the conventional limits. This stability suggests that household debt and assets have been growing at similar speeds, which makes sense for Luxembourg given that mortgages account for most debt and the primary residence is typically the most important asset held by households. This also explains why

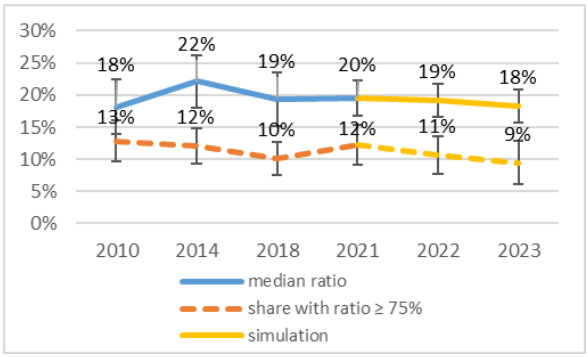
[8] Indebted households are those with credit lines, overdraft debt or credit card debt, outstanding loans (mortgage, consumer, personal, instalment, etc.) from financial institutions and/or relatives, friends, employers, etc. Total debt consists of mortgage and non-mortgage debt.

[9] Confidence intervals are based on 1000 weighted replicates and 5 multiple imputations on the data set.

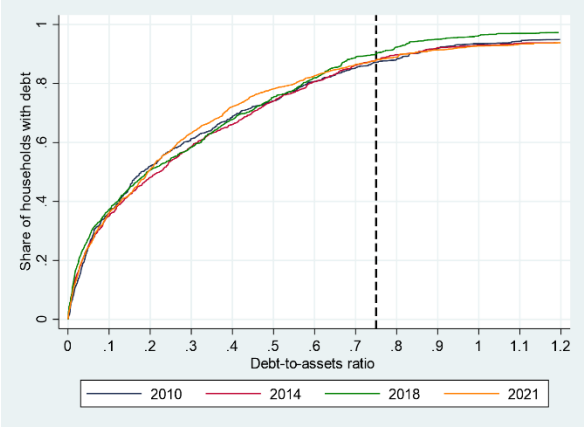
the ratio of debt to financial assets in the household sector (Figure 1) differs from the debt-to-assets ratio calculated from individual data (Figure 3), since the latter ratio also considers real assets, including the household main residence.

Figure 3: Debt-to-assets ratio by year

a) Median ratio and share of financially vulnerable households



b) Cumulative distribution by survey year



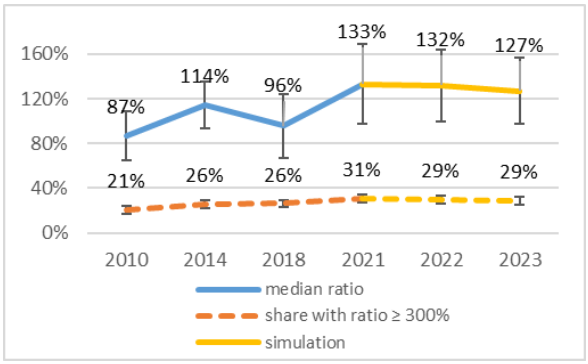
Source: Own calculations based on wave 1 to 4 of the LU-HFCS; data are multiply imputed and weighted. Error bars indicate the 95% confidence interval.
Panel (b): cumulative distribution functions are calculated across all 5 implicates each year. The vertical line indicates the conventional limit. We omit the long upper tail of the cumulative distribution functions.

Simulations for 2022 and 2023 suggest the loan-to-value ratio continued to decline (panel (a) of Figure 2). Both the median value and the share of vulnerable households drop substantially compared to 2018, but the differences are not statistically significant. For the debt-to-asset ratio (Figure 3), the median value also declined in 2022 and 2023, but the difference from 2021 is not statistically significant, as is also the case for the share of vulnerable households.

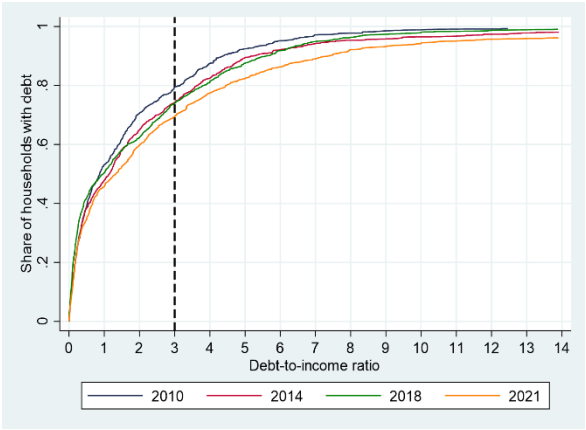
For the debt-to-income ratio (Figure 4) the median value increased considerably between 2018 and 2021, although the difference is not statistically significant. However, in panel (b) of Figure 4 the cumulative distribution clearly shifts to the right in 2021. Thus, between 2018 and 2021 the share of vulnerable households (exceeding the 300% conventional limit for this indicator) rose from 26% to 31% (panel (a) of Figure 4). This suggests that household debt grew faster than household income. Despite the exceptional support measures introduced during the pandemic (partial unemployment, exceptional leave for family reasons) and the economic rebound in 2021, many indebted households still suffered income declines due to restrictions on economic activity. According to the simulations, for the debt-to-income ratio in 2022 and 2023 both its median value and its share of vulnerable households were significantly higher than their levels observed in 2010 (panel (a) of Figure 4).

Figure 4: Debt-to-income ratio by year

a) Median ratio and share of financially vulnerable households



b) Cumulative distribution by survey year

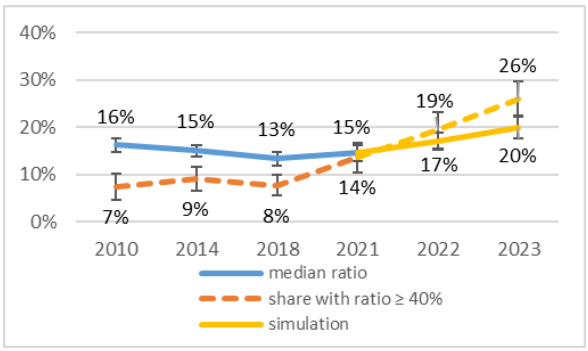


Source: Own calculations based on wave 1 to 4 of the LU-HFCS; data are multiply imputed and weighted. Error bars indicate the 95% confidence interval.
Panel (b): cumulative distribution functions are calculated across all 5 implicates each year. The vertical line indicates the conventional limit. We omit the long upper tail of the cumulative distribution functions.

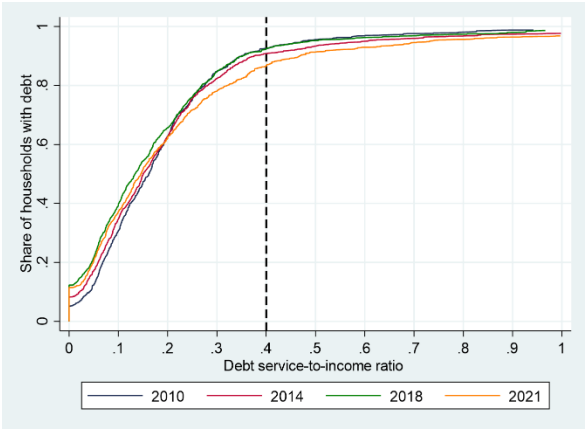
For the debt service-to-income ratio, panel (a) of Figure 5 suggests the median value was relatively stable between 2010 and 2021. However, the share of vulnerable households increased considerably in 2021 (dashed line). Indeed, panel (b) confirms that in 2021 the cumulative distribution shifted to the right starting at the sixtieth percentile (leaving the median unchanged around 15%). Since the values of the ratio that were affected were above 20% (so less than the 40% vulnerability threshold indicated by the dashed vertical line), the shift increased the share of vulnerable households. As with the debt-to-income ratio, this suggests that for many households debt service increased faster than income.

Figure 5: Debt service-to-income ratio by year

a) Median ratio and share of financially vulnerable households



b) Cumulative distribution by survey year



Source: Own calculations based on wave 1 to 4 of the LU-HFCS; data are multiply imputed and weighted. Error bars indicate the 95% confidence interval.
Panel (b): cumulative distribution functions are calculated across all 5 implicates each year. The vertical line indicates the conventional limit. We omit the long upper tail of the cumulative distribution functions.

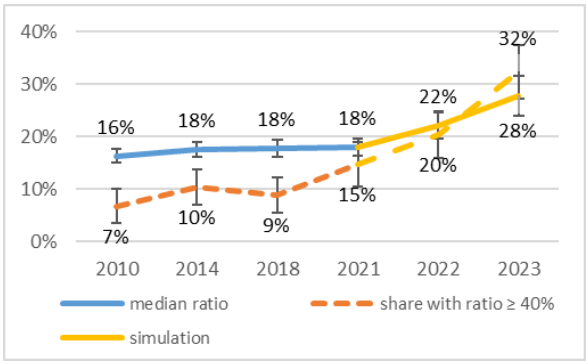
According to the simulations, between 2022 and 2023 the debt service-to-income ratio saw continued increases in both its median value and its share of vulnerable households. This indicator suggests that almost a fifth of indebted households exceeded the conventional threshold in 2022 and more than a quarter in 2023.

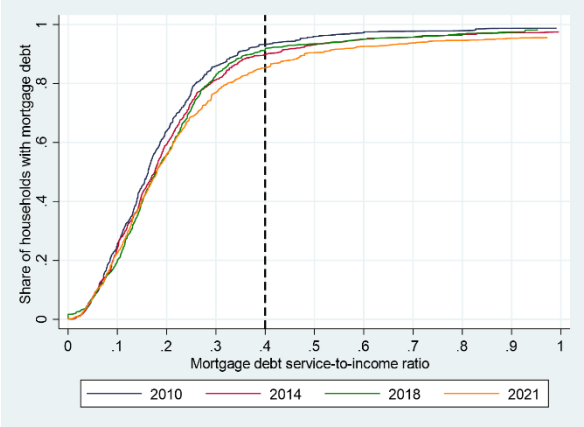
Figure 6 repeats this exercise while only considering debt service on mortgages. In panel (a), the mortgage debt service-to-income ratio displays a relatively stable median until 2021, but its share of vulnerable households increased considerably in 2021 (dashed line). As in Figure 5, the cumulative distribution in panel (b) of Figure 6 shifted to the right in 2021 starting at the seventieth percentile, which corresponds to values of the ratio around 25% (below the 40% vulnerability threshold indicated by the dashed vertical line).

Figure 6: Mortgage debt service-to-income ratio by year

a) Median ratio and share of financially vulnerable households

b) Cumulative distribution by survey year





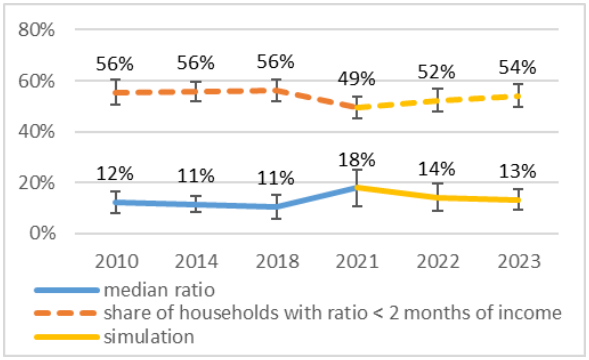
Source: Own calculations based on wave 1 to 4 of the LU-HFCS; data are multiply imputed and weighted. Error bars indicate the 95% confidence interval.
Panel (b): cumulative distribution functions are calculated across all 5 implicates each year. The vertical line indicates the conventional limit. We omit the long upper tail of the cumulative distribution functions.

The simulations suggest that in 2022 and 2023, both the median value and the share of vulnerable households rose even faster. The acceleration is more marked than in Figure 5, suggesting that 32% of households with mortgage debt could be vulnerable in 2023. This may sound alarming, but the next section finds that these vulnerable households account for only a limited share of all mortgage debt outstanding.

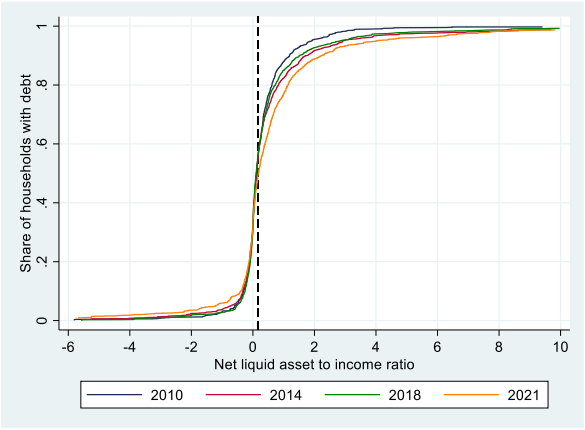
Turning to the ratio of households' net liquid assets to their annual gross income, Figure 7 illustrates that the median value increased from 11% in 2018 to 18% in 2021, while the share of vulnerable households declined from 56% to 49%. The cumulative distribution did not shift to the right in 2021, but flattened out, leading to a more dispersed distribution. Relative to their income, there were more households with a very high stock of net liquid assets in 2021, but also more households with a more negative stock of net liquid assets. These changes may reflect the COVID-19 shock. On the one hand, a significant share of households saw their savings increase during the pandemic, as the restrictions in place limited their possibilities for consumption. Some households also benefited from the stock market boom at the end of 2021. On the other hand, other households had to run down their savings or take on more debt to cope with lower income in 2020 (sharp increase in partial unemployment). According to the simulations, in 2022 and 2023 the ratio of net liquid assets to household income moved back towards its level before the pandemic.

Figure 7: Net liquid asset to income ratio by year

a) Median ratio and share of financially vulnerable households



b) Cumulative distribution by survey year

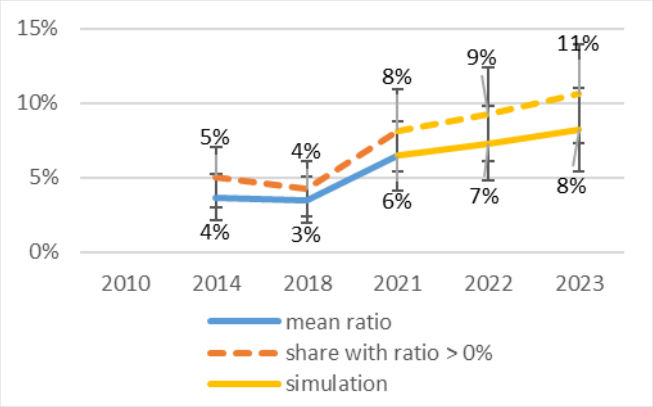


Source: Own calculations based on wave 1 to 4 of the LU-HFCS; data are multiply imputed and weighted. Error bars indicate the 95% confidence interval.
Panel (b): cumulative distribution functions are calculated across all 5 implicates each year. The vertical line indicates the conventional limit. We omit the long upper tail of the cumulative distribution functions.

Finally, the probability of default in Figure 8 is our preferred indicator, because it combines several aspects of the indicators above and approximates the probability that a household will fall behind in its debt payments by at least three months. Its mean value increased significantly from 3% in 2018 to 6% in 2021, while its estimate of the share of vulnerable households increased from 4% to 8%. These increases reflect previous findings, including the increase in debt service relative to the monthly household income and the reduction in net liquid assets for some households. In addition, the scale of the increases suggests other factors may have contributed to the increase in household financial vulnerability, for example the acceleration of inflation in 2021, marking the post-pandemic economic recovery, which may have compressed household financial margins.

According to the simulations, the probability of default among indebted households continued to increase through 2023. According to this indicator, 11% of indebted households could be financially vulnerable in 2023. As explained below, this mainly reflects higher interest rates and, to a lesser extent, the rise in consumer prices. The less dramatic increase in vulnerability between 2021 and 2023 may reflect household support policies activated in 2022 and continued in 2023 (also simulated).

Figure 8: Probability of default by year



Source: Own calculations based on wave 2 to 4 of the LU-HFCS; data are multiply imputed and weighted. Error bars indicate the 95% confidence interval.
Note: Cumulative distribution functions are not presented because the share of households with a positive PD is less than 10% in 2014, 2018 and 2021.

4. Financially vulnerable households by income quintile

For each indicator in Table 1, Figure 9 reports the share of financially vulnerable households by income quintile[10]. Not surprisingly, the share of financially vulnerable households is significantly lower in the higher income quintiles. Likewise, the share of vulnerable households tend to be significantly higher for the most disadvantaged group (the first quintile), especially according to indicators associated with the risk of delayed payment (debt service-to-income ratios and probability of default).

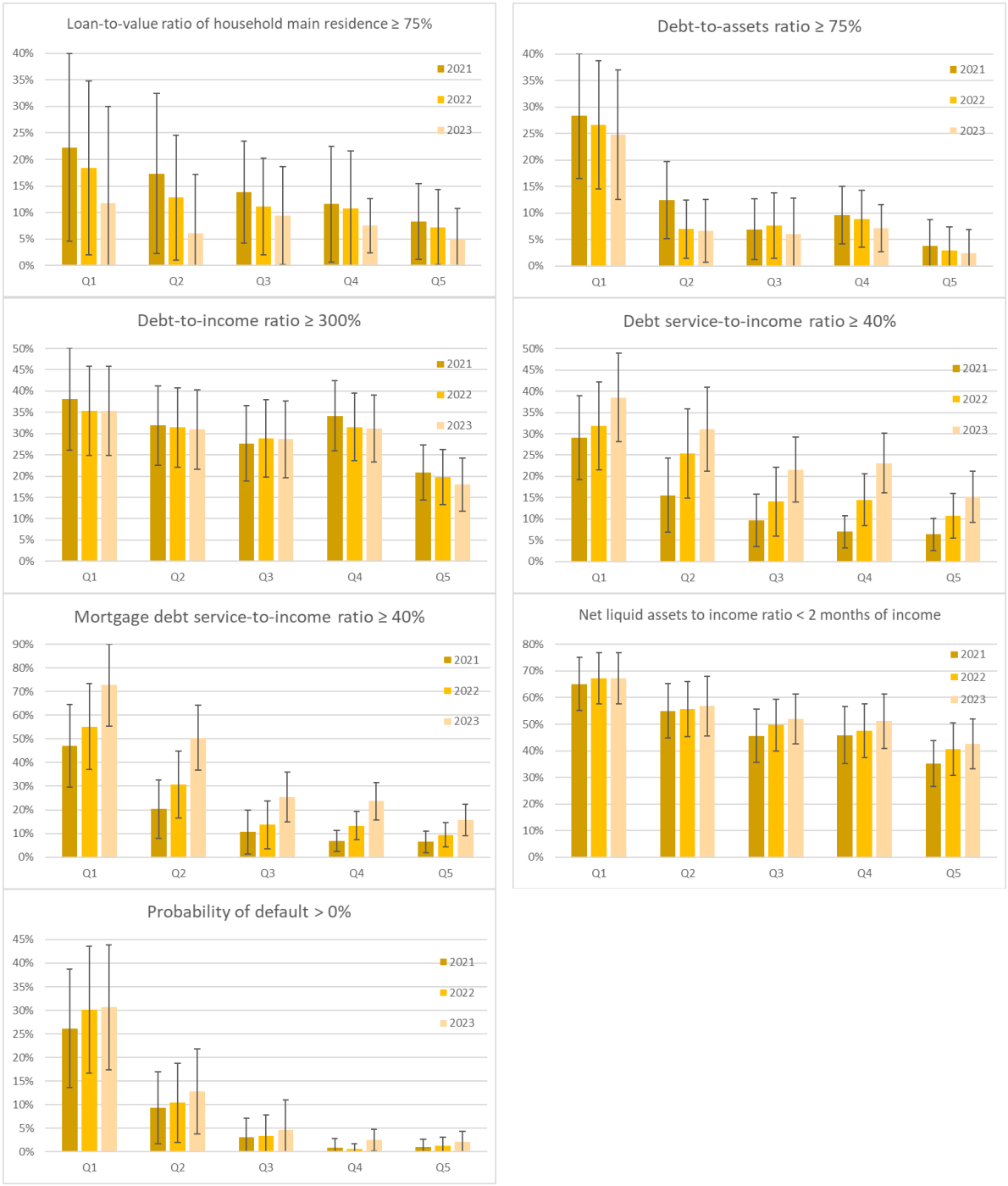
According to the mortgage debt service-to-income ratio, in 2021 almost 50% of households in the lowest income quintile were financially vulnerable. Simulations for 2023 indicate that the share of vulnerable households according to this indicator could exceed 70%. In 2021, this share is only 20% for the second income quintile, 10% in the third quintile, and even less for the top two quintiles (the highest incomes). Again, according to the mortgage debt service-to-income ratio, between 2022 and 2023 the share of financially vulnerable households is expected to increase for all income quintiles. The same conclusions can be drawn for the total debt service-to-income ratio and for the probability of default.

According to the results of this analysis, the risk of accumulating late payments is concentrated among the most disadvantaged households, i.e. those with low income (Figure 10). However, indebted households in the lowest income quintile only account for 9% of aggregate household sector debt (panel a) and for 11% of the number[11] of outstanding mortgage contracts (panel b). This limits the possible impact on private consumption and economic activity at the aggregate level. Therefore, the vulnerability of lower-income households resident in Luxembourg appears to represent only a limited risk for the banking sector as a whole.

[10] Each income quintile represents 20% of the weighted population of indebted households sorted by their level of gross household income in 2020.

[11] The total number of mortgage contracts per household is the sum of the number of mortgages using the household main residence as collateral and the number of mortgages using the two most important other real estate properties as collateral.

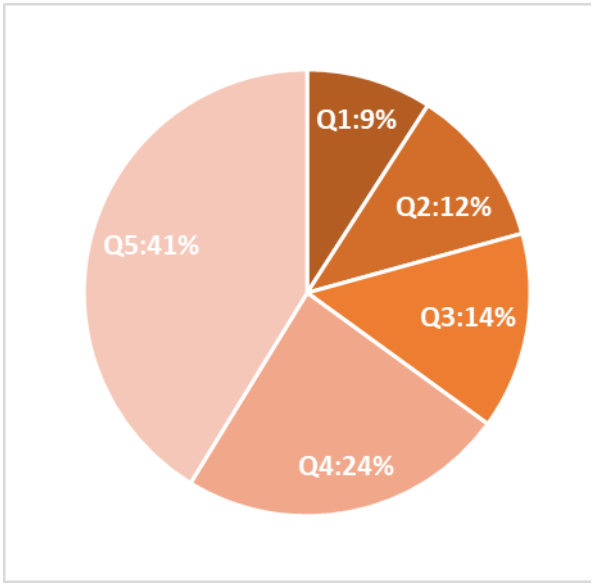
Figure 9: Share of financially vulnerable households by income quintiles in 2021 and by simulation year



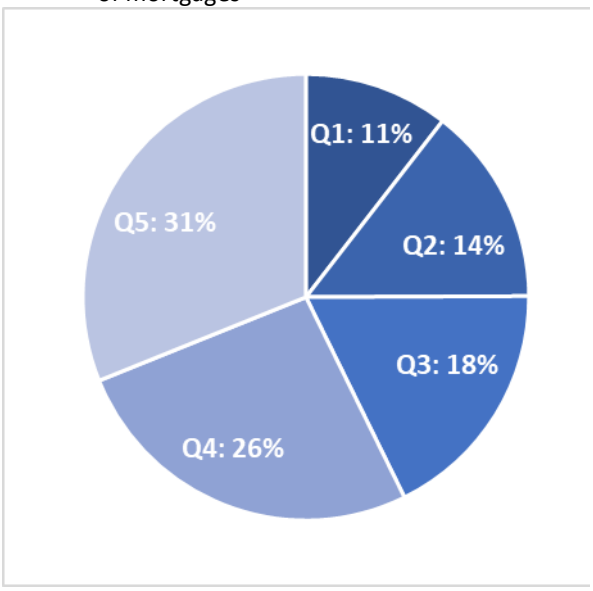
Source: Own calculations based on wave 4 of the LU-HFCS; data are multiply imputed and weighted. Error bars indicate the 95% confidence interval.

Figure 10: Shares in aggregate household sector debt and in total number of mortgages by income quintiles in 2021

a) Income quintile shares of aggregate household sector debt



b) Income quintile shares in the total number of mortgages



Source: Own calculations based on wave 4 of the LU-HFCS; data are multiply imputed and weighted.

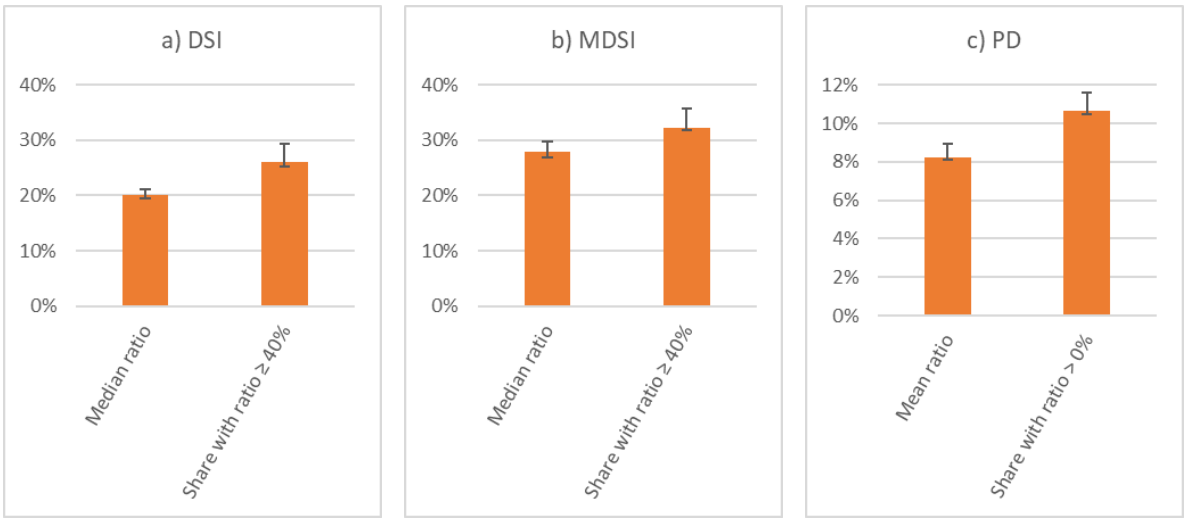
5. Sensitivity analysis

Our micro-simulation exercise is based on the BCL macroeconomic projections of December 2022. As with any macroeconomic projection exercise, they are subject to substantial uncertainty. Therefore, to assess the reliability of our results, we analyse the sensitivity of micro-simulations to alternative assumptions on inflation and interest rates in 2023. These assumptions do not represent a specific alternative scenario to which we could attach a probability. The objective is to evaluate the robustness of our results using extreme values of certain macroeconomic variables. We consider a high and a low trajectory for the various components of inflation and specific interest rates reported in Table 2. In the high trajectory, inflation and interest rates in Table 2 are doubled if they are positive and halved if they are negative. In the low trajectory, values in Table 2 are halved if positive and doubled if negative. Below, we only present results for changes in the interest rate assumptions, since changes in the inflation assumptions had only limited effects.

Figure 11 depicts the impact of changes to interest rate assumptions for each of the three indicators associated with the risk of delayed payment (debt service-to-income ratio, mortgage debt service-to-income ratio and probability of default). These are the only indicators that are affected in the alternative scenario. In the figure, the grey dashes indicate the median value and share of vulnerable households for 2023 as reported earlier and the interval around them illustrate the outcome of the sensitivity exercise. For all three indicators, results only respond weakly to changes in the interest rate assumptions, within limits of less than 5 percentage points. For the debt service-to-income ratio in panel (a), the share of vulnerable households ranges from 25.1% to 29.4%. For the mortgage debt service-to-income ratio in panel (b), the share of vulnerable households ranges from 32% to 36%. For the probability of default in panel (c), the share of vulnerable households may be one percentage point higher than in the baseline simulation.

The outcome of this exercise suggests that our micro-simulation results are fairly robust to variation in the underlying macroeconomic assumptions, despite remaining uncertainty around interest rate developments over 2023.

Figure 11: Interest rate sensitivity of selected debt burden and vulnerability indicators in 2023



Source: Own calculations based on wave 4 of the LU-HFCS; data are multiply imputed and weighted.
Note: Orange bars show point estimates based on the scenario in Table 2. Error bars indicate the range between the high and low trajectory of inflation rates in 2023.

6. Conclusion

According to several indicators, the share of financially vulnerable households in Luxembourg increased from 2018 to 2021. According to our simulations, this trend continued in 2022 and 2023. However, our analysis also suggests that the automatic stabilizers embedded in Luxembourg's institutional setting, as well as the timely fiscal policy interventions, succeeded in limiting the deterioration of households´ financial situation.

Unsurprisingly, the most disadvantaged households are the most vulnerable. However, systemic and macroeconomic risks seem relatively contained, given that those households in the lowest income quintile that are indebted represent only 11% of number of mortgage contracts and represent only 9% of aggregate household sector debt.

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