NBS Working paper
3/2024

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This publication is available on the NBS website

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ISSN 2585-9269 (online)

Estimating Macro DSTI for Selected EU Countries*

Ján Klacso[a]

Abstract

The debt service-to-income ratio represents a critical indicator of retail credit risk. While the calculation of this ratio is straightforward for individual retail clients, obtaining it at the country level presents a more significant challenge. Nevertheless, such a measure can provide early warning signals and can help explaining household consumption throughout the credit cycle. Furthermore, the macro DSTI enables a comparison of debt burden across countries. In this paper we estimate the annual and quarterly ratio of debt service-to-income, or Macro DSTI, for selected EU countries. We make several adjustments to currently available comparable indices, like the Debt Service Ratio calculated by the BIS. The estimation of the index solely for indebted households, with the inclusion of their net income, enables a more accurate reflection of the actual debt service burden at the country level. While the majority of countries observed a decline or stagnation in macro DSTI following the Great Financial Crisis, Slovakia exhibited a notable increase, with a decline starting in 2018 resulting from a reduction in consumer loans.

JEL codes: C8, E44, E50, G21

Keywords: Debt service-to-income ratio, indebted households, household credit risk

* We are grateful for Nico Valckx, Antoine Baena and Reiner Martin for their excellent comments and suggestions and for Tobias Foriš and Denys Orlov for their valuable help.

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Non-technical summary

Household indebtedness and its development is one of the most closely followed metrics in relation to financial stability, especially following the global financial crisis. However, the importance of the debt service burden in addition to the level of indebtedness in itself is increasingly being acknowledged. The debt service ratio at the macro, or country level can provide significant insight into the evolution of the debt burden and its potential implications for financial stability or household consumption, also making cross country comparison more straightforward. Furthermore, it is already evidenced that such debt service ratios at a country level can serve as an important indicator of forthcoming recessions.

While the calculation of the debt burden is relatively straightforward when utilising micro level data, the situation is more complex when calculating at the country level. The absence of data regarding the remaining maturity, the disposable income of indebted households, the loan structure, and for some countries the loan interest rates necessitate the utilization of disparate assumptions.

In this paper, we enhance the estimation of the currently used debt service burden measures at the country level, or Macro DSTI, in several ways. Firstly, we utilise the most precise data available for interest rates and remaining maturities, thereby ensuring not only an accurate representation of the trend but also the level. The remaining maturities are derived from data obtained from the Household Finance and Consumption Survey. Secondly, we use net income of households to account for differences in the taxation among countries. Thirdly, by utilising the same survey, we estimate not only the debt burden of households in a specific country, but also the debt burden of only those households that are indebted, thus providing a more accurate representation of the actual debt burden of these households. This enables us to monitor the evolution of the debt burden of households over time and to directly compare it between different countries.

Comparing different proxies for the debt burden — using gross income for all households versus net income for only indebted households — reveals how sensitive results are to various assumptions and income metrics. The level of debt burden can vary significantly, and differences in taxation and indebtedness levels can alter qualitative conclusions in cross country comparisons.

Our findings indicate that the early warning capabilities of Macro DSTI are on par with the Debt Service Burden index from the Bank for International Settlements. Both indices show similar trends, but Macro DSTI is more efficient as it considers the ratio of indebted households and its changes over time.

While Macro DSTI was stagnating or decreasing in the majority of countries after the global financial crisis, Slovakia exhibited a rapid increase until 2018. During this period, the rising volume of loans was only partially offset by rising income and declining mortgage interest rates. A change in the trend occurred only after the volume of consumer loans started to decrease.

1. Introduction

The level of indebtedness of households is closely followed by central banks and macroprudential authorities. If the indebtedness reaches high enough levels, even a small shock can trigger the materialisation of household credit risk with adverse consequences for the financial sector and, indirectly, the real economy through lower consumption and credit. This is well recognised by macroprudential authorities, as evidenced by the growing number of activated borrower-based measures (BBMs) after the Great Financial Crisis. These measures can be broadly classified into two categories: value-based (loan-to-value, LTV) and income-based (debt-to-income, DTI or debt service-to-income, DSTI). The introduction of DTI or DSTI limits is a crucial step in enhancing the resilience of individual households and, consequently, the household sector as a whole.

Indicators like DTI or DSTI are important also at the macro-, or country-level. Although rising household indebtedness may initially stimulate consumption, this effect may ultimately prove to be counterproductive in the medium and long term (Han, et al., 2019). The higher is the household indebtedness, the higher is the probability of a negative impact on consumption or GDP. Based on the estimates provided by the Bank for International Settlements, or BIS (Lombardi, et al., 2017), the negative long-run effects of the household indebtedness on consumption are intensified when the household debt-to-GDP ratio exceeds 60%, and the same is true for GDP growth when this ratio exceeds 80%. (Alter, et al., 2018) identifies three channels through which high household debt may impact future GDP. Firstly, an increase in household debt may amplify the probability of a future banking crisis, which could significantly disrupt financial intermediation. Secondly, the so-called "crash risk" may be systematically neglected due to investors' overoptimistic expectations associated with household debt booms. Finally, high debt may negatively affect household consumption in the event of a negative shock.

The potential for a negative shock to have a detrimental impact on the financial sector and the real economy is also contingent upon the capacity to service debt, in addition to the level of indebtedness itself. The sensitivity of interest rates, the maturity of debt, and the overall debt burden are all significant factors (Zabai, 2017). In the event of a negative shock, for example, in the form of a reduction in income or employment loss, it is the cash flow of the household that is initially affected. While in general the volume of housing loans is higher compared to consumer loans, they have longer maturity and lower interest rates. Consider a housing loan with a notional amount of 100 000 EUR, an interest rate of 0.9% p.a. and a maturity of 20 years. The monthly instalment of this loan is 456 EUR, which is equivalent to the monthly instalment of a consumer loan with a notional amount of approximately 30 000 EUR, an interest rate of 7.9% p.a. and a maturity of 7 years[1]. Despite the volume of the housing loan being more than three times that of the consumer loan, the cash flow of the two households is constrained by the two loans in the same way.

The significance of DSTI in the context of household credit risk is increasingly being acknowledged. Plenty of studies provide evidence of the importance of debt burden or DSTI limits (see, e.g., (Hunt, 2015) or (Dietsch & Welter-Nicol, 2014)). A particularly pertinent example of a negative shock is the impact of the global Covid-19 pandemic, which has had a significant effect on the cash flow of households. The Slovak experience is documented in (Cesnak, et al., 2023). While the default rate of households remained low due to the possibility of loan repayments deferral, households with high pre-crisis DSTI had a higher probability of requesting such a deferral. While the distribution of the DSTI of individual households can

[1] The interest rates are equal to the average interest rates on newly granted housing loans and consumer loans with a fixation from 1 to 5 years in Slovakia as of December 2021.

provide insight into the concentration of credit risk based on the socio-demographic characteristics of the households, such data is not commonly available.

Conversely, the debt service ratio at the macro level, or country level, can also provide significant insight into the evolution of the debt burden and its potential implications for financial stability or household consumption. Furthermore, comparisons between countries are more straightforward. Such a Debt Service Ratio (DSR) is constructed and assessed at the country level in (Drehmann & Juselius, 2012) and in (Drehmann, et al., 2015) for the non-financial private sector and, where possible, for households and corporations separately. The objective of this paper is to construct a macro DSTI for households in selected EU countries. In some cases, the DSR is already accessible in the database of BIS based on the methodology outlined in (Drehmann & Juselius, 2012). We extend this indicator for new countries that are currently not captured by the BIS. The countries included in the study were selected based on two criteria: data availability and the structure of their mortgage markets. While previous literature has employed a number of assumptions regarding parameters such as maturity and interest rates, we utilise the most precise data available to ensure that the development of the DSTI not only reflects changes in the trend but also in the level of debt. Furthermore, we estimate the debt burden not only at the country level or the level of households, but also at the level of indebted households, in order to gain a more accurate understanding of the debt burden faced by the indebted population.

The paper is structured as follows. Section 2 outlines the principal challenges associated with the construction of DSTI at the country or macro level. Section 3 provides a summary of the data employed and the methodology deployed. Section 4 presents the evolution of the constructed macro DSTI ratios, showcasing the gradual refinement and enhancement of the methodology. Section 5 offers a comparison of the performance of the constructed macro DSTI and the DSR calculated by the BIS. The paper concludes with a summary and an overview of the key findings.

2. Challenges in constructing DSTI ratios at a macro level

A number of studies have been conducted to examine the relationship between credit risk and DSTI, and, in the wake of the Global Financial Crisis, the impact of DSTI limits imposed by macroprudential authorities on the credit risk profile of households. In order to conduct such an analysis, it is typically necessary to utilise micro-level data, which is obtained either through surveys or by employing individual loan-level data. (Holló & Papp, 2007) employ survey-level data to evaluate the credit risk of households. The analysis confirms that household credit risk is affected by a number of individual factors, including the income share allocated to monthly debt servicing costs. Individual loan-level data are employed in (Dietsch & Welter-Nicol, 2014) or in (Hodula, et al., 2022) to assess the impact of borrower-based measures (including DSTI limits), on the lending market and on banks in general. As previously stated in the introduction, the calculation of debt burden, or DSTI, is a relatively straightforward process when utilising micro-level data. Researchers typically possess the necessary information regarding the volume of debt, interest rate, maturity, and income at the household or debtor level, which is essential for the calculation.

The situation becomes more complex when calculating DSTI at the macroeconomic or country level. The absence of data regarding the remaining maturity, the disposable income of indebted households, and the loan structure necessitates the utilization of disparate assumptions. In order to estimate debt servicing in the form of loan servicing in relation to disposable income for Estonian households, it was necessary to make assumptions regarding principal payments due to a lack of available statistical data (Kask, 2003). Debt service ratios for selected countries are also calculated in (Drehmann & Juselius, 2012) and (Drehmann, et al., 2015). The ratios are calculated for the non-financial private sector as a whole, and, where possible, separately for

households and for non-financial corporations. In the case of calculations pertaining to the entire private sector or non-financial corporations, income was approximated by GDP. Furthermore, the authors emphasise the lack of available amortisation data, which presents a significant challenge in estimating these ratios. For the households an assumption of instalment loans is used, and authors show that the repayment structures of individual loans tend to cancel out in aggregate. Furthermore, simplifying assumptions are employed in relation to the remaining maturities. While these assumptions have an impact on the level of the ratio, they do not affect the trends. Consequently, even if different assumptions are used, the calculated ratios can serve as early warning indicators, as they tend to predict crisis periods relatively well.

This paper contributes to the existing body of research on the debt service burden in a number of ways. Firstly, in lieu of assumptions, we utilise the most precise data available for interest rates and remaining maturities, thereby ensuring not only an accurate representation of the trend but also the level. The remaining maturities are derived from data obtained from the Household Finance and Consumption Survey (HFCS)[2]. Secondly, by utilising the same survey, we are able to estimate not only the debt burden of households in a specific country, but also the debt burden of only those households that are indebted, thus providing a more accurate representation of the actual debt burden of these households. Furthermore, we present the Macro DSTI for a group of EU countries, some of which are currently not included in the BIS database. This enables us to monitor the evolution of the debt burden of households over time and to directly compare it between different countries.

3. Data and methodology

We estimate the Macro DSTI for selected EU countries[3]. The countries included were selected based on data availability and the structure of their mortgage market[4], with the aim of creating a set of countries with a mortgage market structure comparable to that of Slovakia. Following (Drehmann, et al., 2015), we estimate DSTI based on the assumption of amortizing loans, i.e., loans with constant payments including the repayment of interest and principal. It means we employ the standard formula for calculating the DSTI in the form of:

$$DSTI = \frac{P}{I}$$

where I is the income of households and P is the debt payment calculated as

$$P = NA\frac{r}{1-(1+r)^{-n}}$$

NA is the outstanding notional amount of the loan; r is the interest rate (monthly/quarterly/p.a. based on the frequency of the data used) and n is the number of remaining payments.

The data regarding loans was obtained from the ECB Statistical Database for the majority of countries, primarily those within the euro area (EA). The data regarding the outstanding amount of loans for house purchase and consumer loans were obtained from the Balance Sheet Items (BSI) dataset. The data regarding interest rates (annualised agreed rate) were obtained from the MFI Interest Rate Statistics (MIR) dataset. In the case of some countries, primarily non-EA countries, national databases had to be utilised. As the reporting of mortgage loans and

[2] More details about this survey can be find here: https://www.ecb.europa.eu/pub/economic-research/research-networks/html/researcher_hfcn.en.html

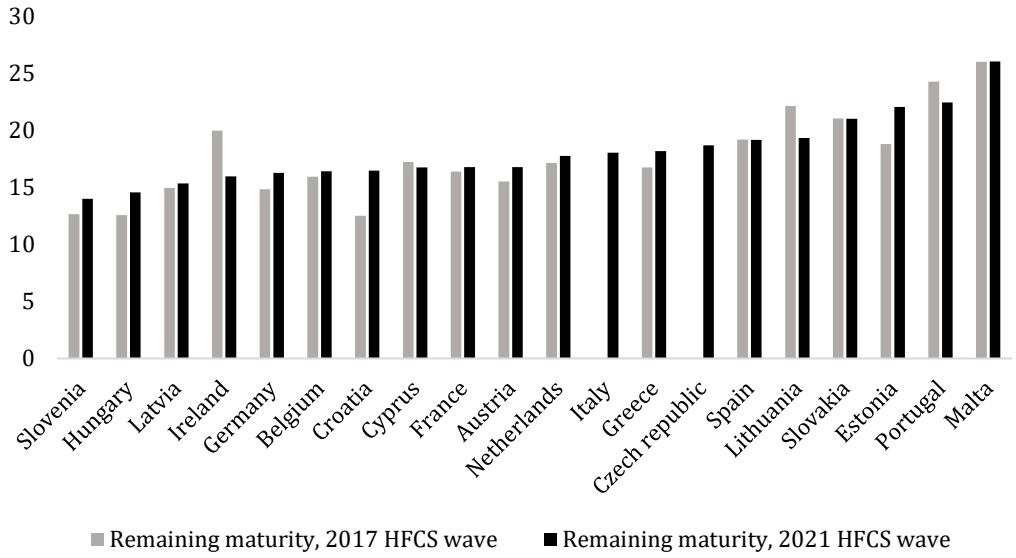
[3] The set of countries covered: Austria, Belgium, Czech Republic, Germany, Estonia, Spain, Finland, France, Hungary, Ireland, Italy, Lithuania, Latvia, Netherland, Poland, Portugal, Slovenia and Slovakia.

[4] As an example, Denmark was excluded from the list as in this country the financing is split between mortgage banks and commercial banks, making the estimation of the overall debt burden more complicated.

consumer loans for Slovakia commenced only in 2006, the estimation of macro DSTI is presented in the paper from this year onwards..

As publicly available data concerning the remaining maturity of retail loans in the countries included in the study are absent, we have used data from the third and fourth waves of the HFCS data set. The aforementioned waves encompass the years 2017 and 2021, respectively. Households with a housing loan were surveyed and asked to provide information regarding the remaining maturity of the loan, expressed in years. In the case of countries for which HFCS data were available, the average outstanding maturity derived from the survey was employed (Chart 1). In the absence of data from the survey or information about outstanding maturity in countries not covered by the survey, we have used average maturities across countries reporting this information in the survey. It should be noted that the survey does not contain information about remaining maturities for other types of loans. For these loans, we have assumed the average outstanding maturity to be seven years, which aligns closely with the monthly bank reporting of retail debt payments in Slovakia (Chart 2)[5].

Chart 1 Average remaining maturity of housing loans based on HFCS data (in years)



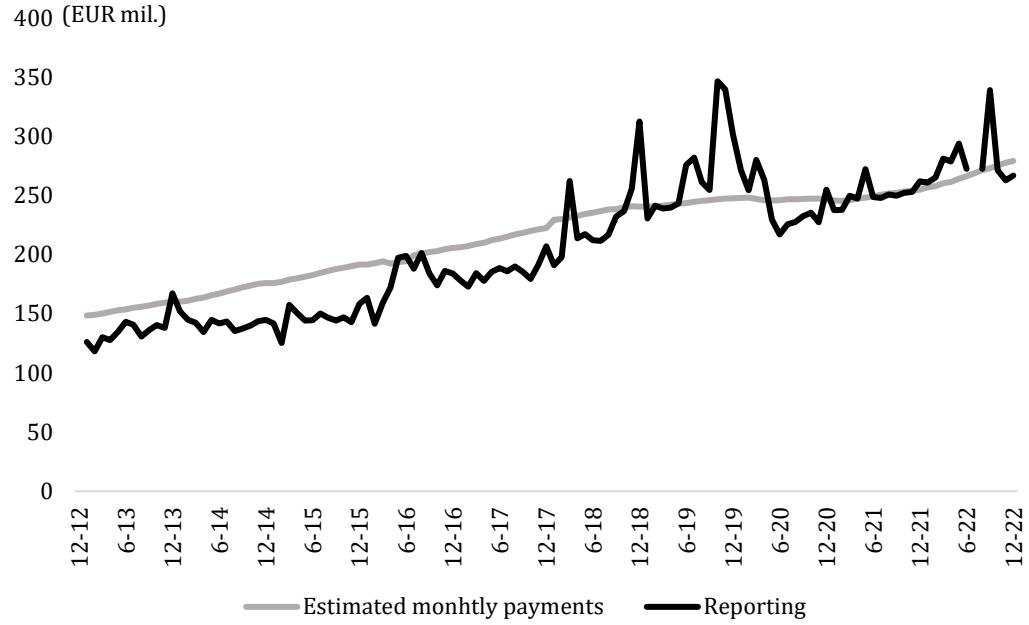
Source: HFCS.
Note: the chart includes data for all the countries available from the survey. Not all surveyed countries are included in the calculation of the debt burden.

To obtain monthly debt payments, we assume loan payments are constant over time and all loans are amortised, i.e. there are no interest only loans. As evidenced by (EMF, 2019), this is indeed the case in the majority of countries included in the study, with only a minor proportion of interest-only or hybrid loans. Further evidence on the minimal discrepancy between the debt payments of hybrid and amortising-only loans at the country level can be found in Appendix 1.

The Netherlands is the only country where a relatively large proportion of interest-only loans were observed, without any apparent need for savings or investment. Based on (DNB, 2017), the proportion of such loans in the mortgage portfolio was 55% in 2017, with a declining trend of 2 p.p. annually. Consequently, for this country, we assumed a declining proportion of interest-only loans in the overall mortgage portfolio.

[5] The maturity based on minimizing mean square errors between the actual reporting and the estimated debt payments.

Chart 2 Monthly retail debt payments in Slovakia



Source: NBS.
Note: The reporting of monthly debt repayments by Slovak banks started in 2013, therefore we cannot compare the two payments for the whole estimated period.

In order to calculate the denominator, two alternative data sets pertaining to household income are employed. The first variable is wages and salaries[6], the second is gross disposable income[7]. Wages and salaries encompass all expenses pertaining to the total gross remuneration of employees, whether in cash or in kind. Disposable income incorporates all income derived from work (employee wages and earnings from self-employment), private income from investment and property, transfers between households, and all social transfers received in cash. A more comprehensive comparison of the two variables is available in Appendix 2.

4. Development of the Macro DSTI

The basic methodology points to decreasing/stagnating DSTI after the GFC in most countries except Slovakia

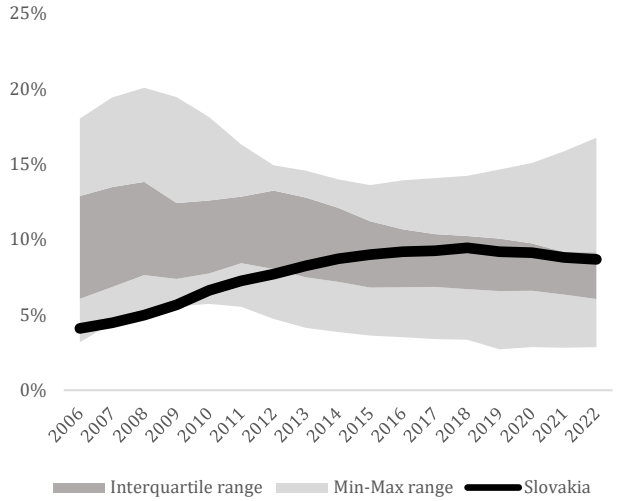
As we use two alternatives for measuring households' income, we provide the figures both with wages and salaries and with gross disposable income (Chart 3). We can observe in both cases a general decrease/stagnation in the Macro DSTI in the majority of countries following the GFC (country-level DSTI is available in Appendix 3, Chart 14). Contrary, DSTI in Slovakia exhibited a consistent increase until 2018, resulting in a notable elevation from levels near the minimum in 2006 to levels within the 3rd quartile (based on wages and salaries) or the median (based on gross disposable income). This indicates that the rapid expansion of household indebtedness also contributed to an increase in the overall debt burden.

[6] We take wages and salaries from the Eurostat Database, GDP and main components (nama_10_gdp).

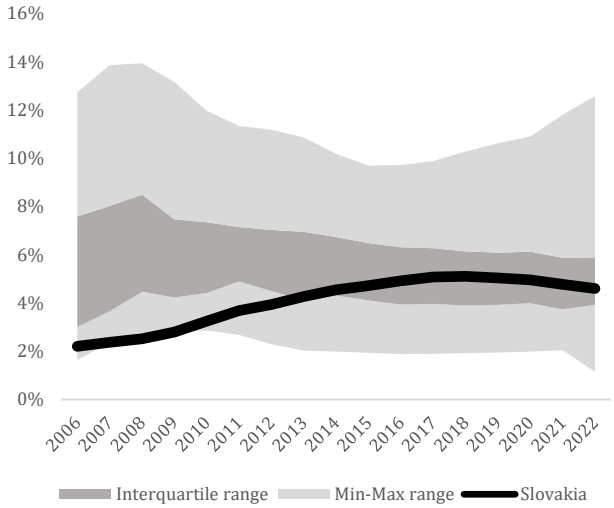
[7] We take gross disposable income from the Eurostat Database, Sectoral accounts, Non-financial transactions (nasa_10_nf_tr).

Chart 3 Development of the Macro DSTI since 2006

a) denominator: wages and salaries



b) denominator: gross disposable income



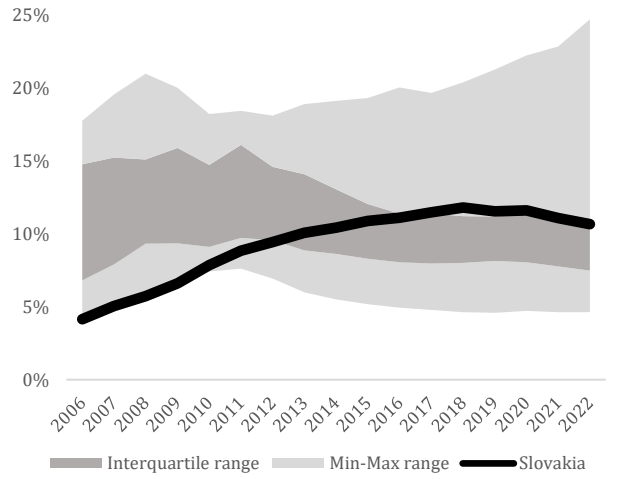
Source: NBS, ECB, Eurostat, HFCS

Incorporating country differences in taxation changes the results a bit but the main messages remain the same

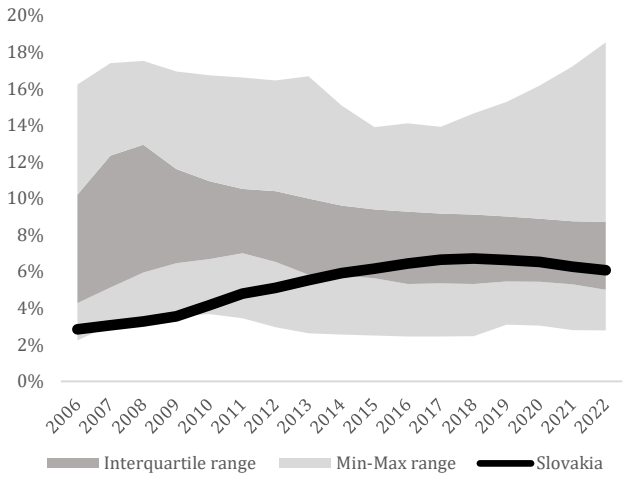
While gross wages and salaries or gross disposable income provide a preliminary insight into the evolution of debt burden, the overall debt burden is underestimated and not entirely comparable across countries due to differences in taxation. To address this limitation, we estimated net wages and net disposable income. To estimate the former, we employed data regarding the number of employed individuals and the average net wage in the respective countries, obtained from Eurostat[8]. By multiplying these two data points, we obtained an estimate of the overall net wages in the countries. Net disposable income was estimated by multiplying the share of net wages on gross wages and the gross disposable income in the respective countries.

Chart 4 Estimation of Macro DSTI using net wages and net disposable income

a) denominator: net wages and salaries



b) denominator: net disposable income



Source: NBS, ECB, Eurostat, HFCS

[8] Number of employed aged between 15 and 64. Available from the Eurostat Database, Employment by sex, age and citizenship (lfsa_egan). Average net earnings of a single person without children earning 100% of the average earning. Available from the Eurostat Database, Labour market, Earning, Net earnings and tax rates (earn_nt_net).

In this case, the estimation of the debt burden is somewhat higher (Chart 4). Additionally, the interquartile and minimum-maximum ranges exhibit slight changes due to variations in taxation policies across countries, which influence countries with the lowest or highest DSTI values. However, the overall conclusion remains consistent with the previous case. While the debt burden remained stagnant or decreased in most countries, Slovak households experienced a notable increase until 2018, reaching the third quartile in the case of wages and nearly the median in the case of net disposable income. Country-level figures are again available in Appendix 3, Chart 15.

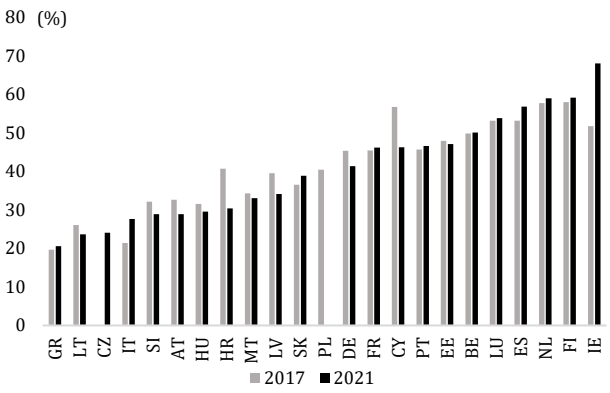
Estimating DSTI for only indebted households significantly increases the debt burden, especially for Slovakia

Although this index now encompasses the debt burden of households in relation to their net income, it still lacks the requisite data concerning the debt burden of solely indebted households. However, it should be noted that the income of only those households with debt is not publicly available for all the countries under consideration. In order to obtain an estimation of the income of indebted households, data from the HFCS survey is employed again. In order to obtain an estimation of the income of indebted households, two sets of information from the survey are utilised. The first is the share of households with a debt in relation to the total number of households. The second is the share of (average) income of these households in relation to the (average) income of all households.

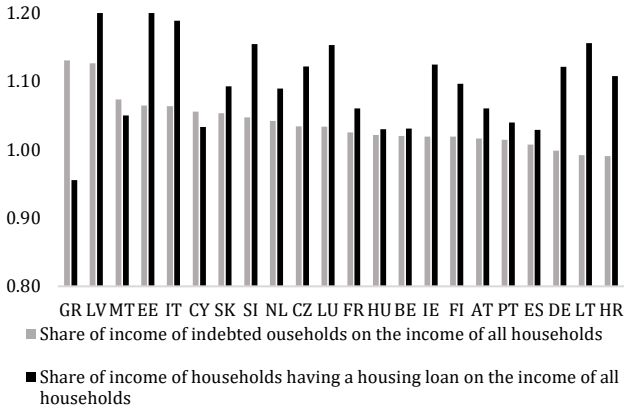
The data presented in Chart 5 a) the proportion of households with a loan out of the total number of households surveyed in the last two waves, conducted in 2017 and 2021. In the majority of countries, there is no notable discrepancy between the proportions observed in the two survey waves. The lowest proportion of indebted households is observed in Greece, where around 20% of households are indebted. In contrast, the highest proportion is found in Ireland, where this figure reaches 68% in the 2021 wave. In Slovakia, almost 40% of households have some form of loan, whether housing-related or consumer-related. As the debt burden is calculated for all households with some form of debt, the income of these households is, in general, not significantly different from the income of all households (Chart 5 b). The proportion of households in the 2021 wave ranges from 99% in Croatia to 113% in Greece. Conversely, a comparison of the income of households with at least one housing loan to the income of all households reveals that the former is significantly higher in most countries. This indicates that, in general, it is households with higher incomes who qualify for housing loans, and that home ownership is more prevalent among households with income above 60% of the median income (Bouyon, 2015).

Chart 5 Share and income of indebted households – survey data

a) share of households having debt



b) income of indebted households compared to all households, 2021 wave



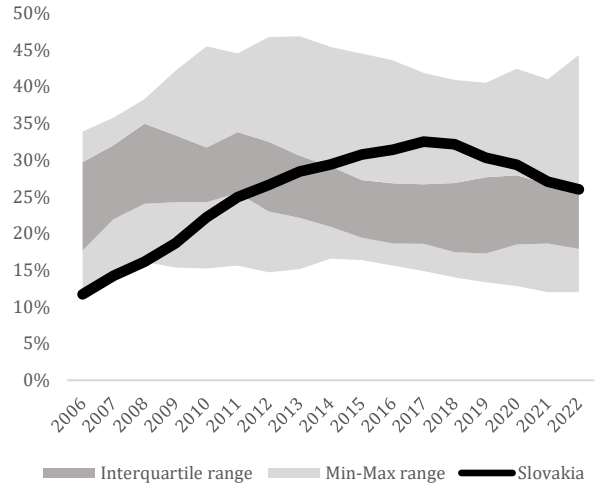
Source: HFCS

The debt service ratio of indebted households exhibits a range of 10% to 50% in the case of net wages and salaries and a range of 7% to 30% in the case of net disposable income (Chart 6)[9]. These ratios are considerably higher than those estimated for the entire household sector.

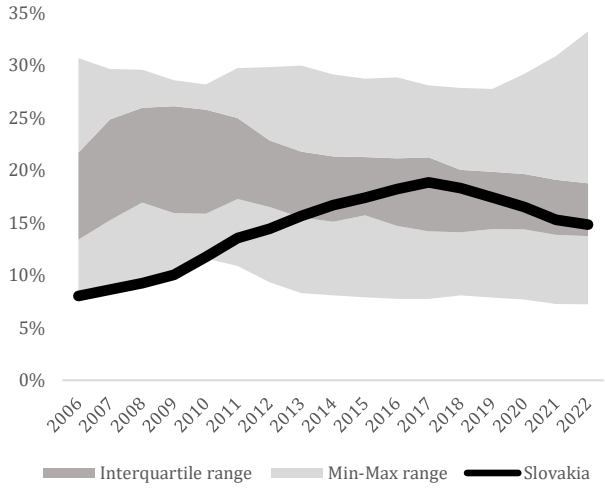
While the proportion of indebted households in Slovakia is lower than in the majority of the countries included in the calculations, the proportion of indebtedness decreased in some of them between the 2017 and 2021 HFCS waves. Therefore, the debt service ratio in Slovakia reached its peak in 2017, falling within the third quartile and at the maximum in the case of net wages and salaries (Chart 6a) and approaching the third quartile in the case of net disposable income (Chart 6b). After 2017, the DSTI exhibited a decline, reaching a level proximate to the third quartile in the case of wages and salaries and approaching the median in the case of disposable income. Country-level figures are again available in Appendix 3, Chart 16.

Chart 6 Estimation of Macro DSTI for only indebted households

a) denominator: net wages and salaries



b) denominator: net disposable income



Source: NBS, ECB, Eurostat, HFCS

If micro data are available for loans granted to households, it is possible to compare the estimated Macro DSTI and the average DSTI calculated from these micro data. In Slovakia, loan level data are available for supervisory purposes. More details about the credit register are available, e.g., in (Klacso, 2023). Based on the credit register, the average DSTI was slightly above 30% in 2021. As the income data available from the credit register includes mainly net wages of the borrowers, it is feasible to compare this number and the Macro DSTI using net wages and salaries as the denominator. In 2021[10], the value of the Macro DSTI was 27%, which is slightly below the average based on micro data but nevertheless correlates relatively well. Naturally, there are several reasons why the two values do not match perfectly. Firstly, the Macro DSTI uses inputs form the HFCS survey, containing only representative data not covering the whole population. Secondly, we employ simplifying assumptions regarding the residual maturity of loans other than mortgages. Thirdly, the income available from the credit register is only the income at the time when the loan was granted. As for the calculation of DSTI we need

[9] The impact of the taxation and taking into consideration only the income of indebted households can be measured via, e.g., rank correlation. The impact of the taxation on the rank of the countries is not so high. The correlation between the rank of the countries using gross or net wages reaches 0.84 in 2011 and 0.90 in 2022. The impact is way higher in case we take into account only the income of indebted households. The rank correlation of the countries using gross wages or net wages of indebted households is 0.32 in 2011 and 0.36 in 2022.

[10] We use data from 2021 for comparison as this is the last year for which monthly statistics are available for average wages from the Statistical Office of the Slovak Republic. Since 2022, only quarterly data are published and therefore the estimation is less accurate.

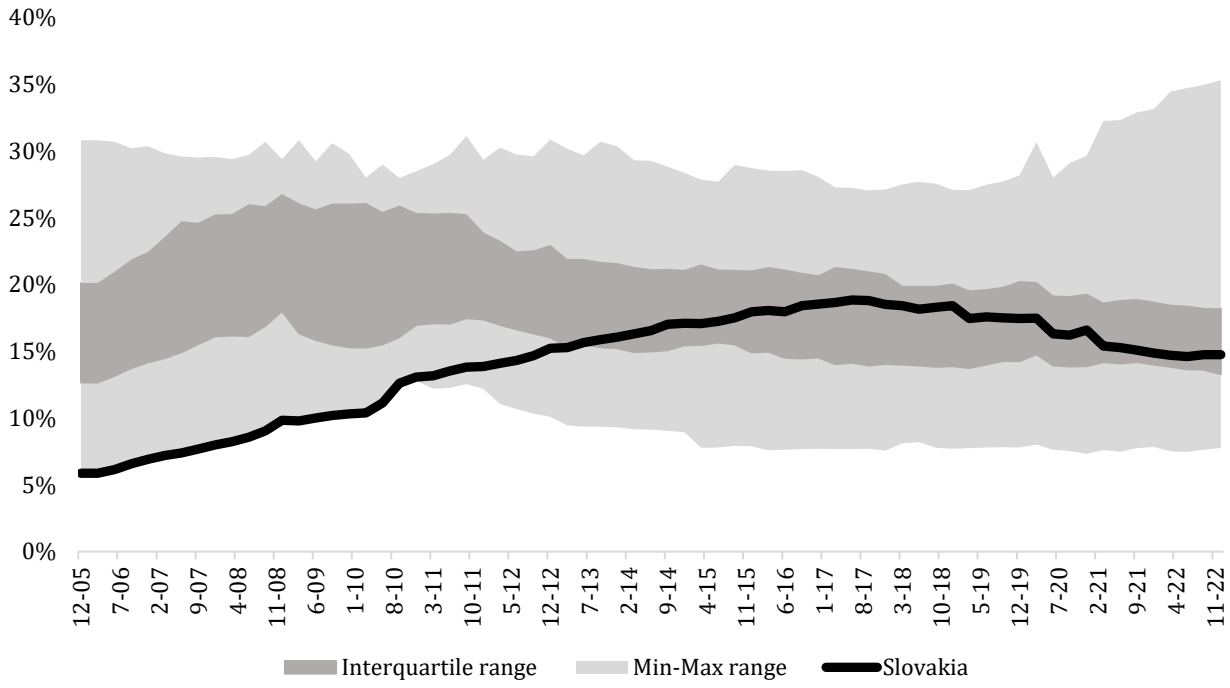
actual income, this income in the case of micro data is only estimated based on the average income development in Slovakia.

For DSTI using net income and calculated for only indebted households, quarterly series can be constructed as well

The comparison of different proxies for the debt burden in this section demonstrates the extent to which the results are sensitive to assumptions and the use of different metrics of income. It is not only the level of debt burden that is subject to change; due to differences in taxation and the level of indebtedness, cross-country comparisons may also yield different qualitative conclusions.

We deem the last estimation using net disposable income and only indebted households as the best measure to capture the debt burden of the indebted households. The evolution of this measure is also illustrated using quarterly data (Chart 7). To obtain quarterly indices of debt burden, seasonally adjusted data regarding gross disposable income is employed. In the absence of gross disposable income data on a quarterly basis for a given country, an estimate is produced using the mean ratio of quarterly gross disposable income to annual gross disposable income across countries where quarterly data are available. Finally, net disposable income is estimated in a manner analogous to that described above, utilising the proportion of gross and net wages. Country-level figures are available in Appendix 4. Finally, as a robustness analysis, in Appendix 5 we provide the estimation of quarterly Macro DSTI using equal mortgage loan maturities of 20 years in all countries.

Chart 7 Estimation of Macro DSTI using net disposable income of only indebted households – quarterly data



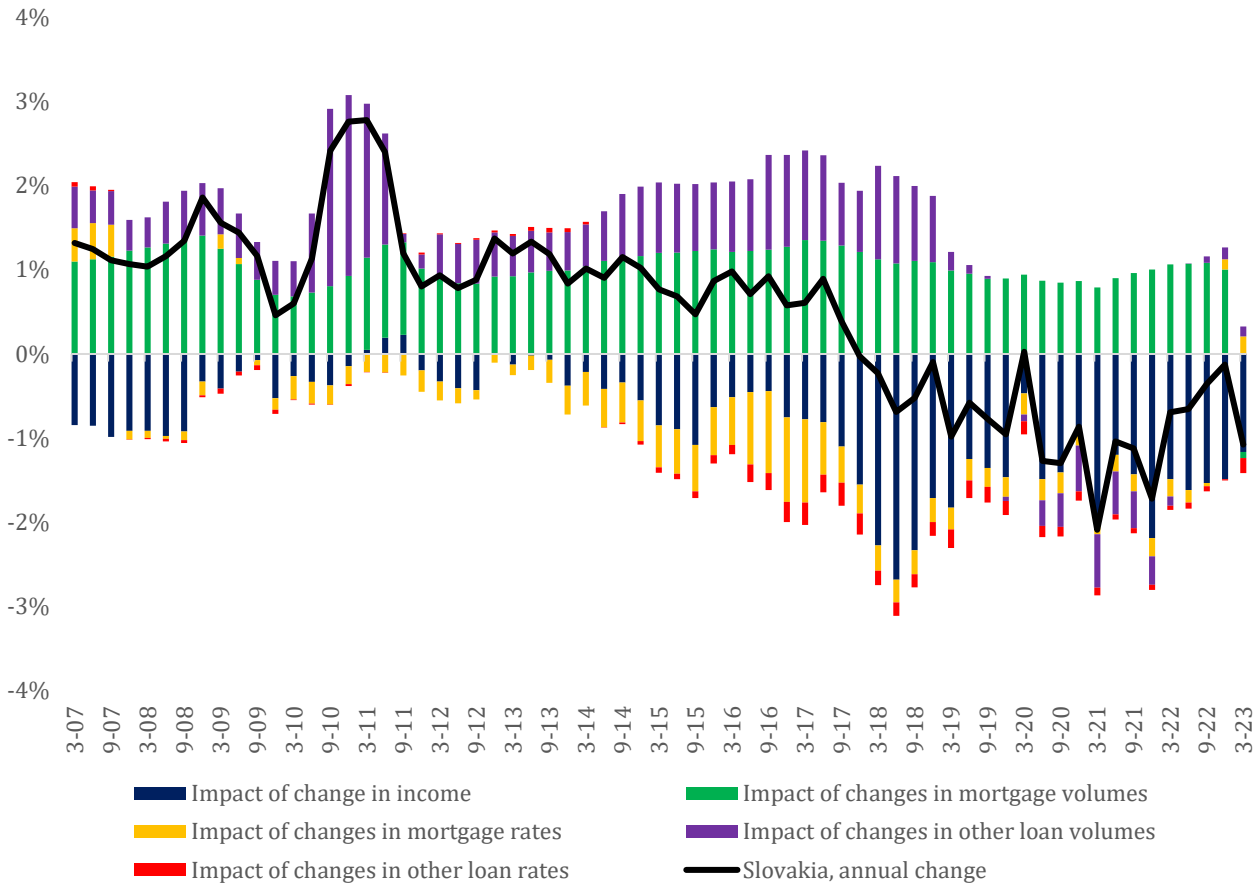
Source: NBS, ECB, Eurostat, HFCS

Changes in DSTI can be decomposed into the main contributing factors, i.e. to changes in the volume and interest rates of respective loans and income changes

The development of the DSTI is affected by several factors. These factors include changes in the income, the volume of housing loans, the volume of other loans and the interest rates on these loans. The DSTI was increasing in Slovakia until 2018 (Chart 8), with mild negative annual

changes after. The decomposition[11] of the DSTI changes into the respective factors reveals that the primary contributors to the growth in the debt burden are the expansion of both housing and other loans. The DSTI began to decline following a reduction in the volume of other loans. The reduction in mortgage interest rates and the growth in disposable income resulted in a decline in the level of debt burden, with the most substantial negative contribution from income observed in 2018. Interest rates on other loans exerted a differential influence across different periods, yet they were not the primary driver of the debt burden's evolution. The decomposition of the changes in Macro DSTI for other countries is available in Appendix 6.

Chart 8 Decomposition of the annual change of the Macro DSTI using net disposable income of only indebted households – Slovakia



Source: NBS, ECB, Eurostat, HFCS

5. Early warning properties of the Macro DSTI

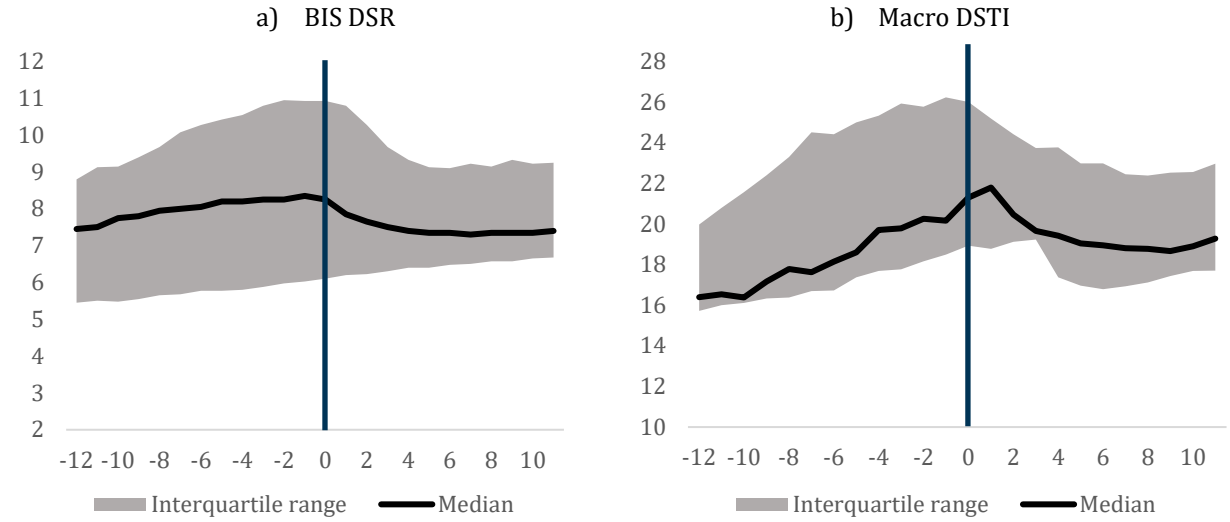
As argued by (Drehmann & Juselius, 2012) and (Drehmann, et al., 2015), debt service ratios at a country level can serve as an important indicator of forthcoming recessions. Furthermore, the aforementioned publications demonstrate the efficacy of the debt service ratio in comparison to alternative metrics, such as the credit-to-GDP gap. Accordingly, this section presents a comparison of the early warning properties of the Macro DSTI and the Debt Service Ratio constructed by the aforementioned authors (referred to as the BIS DSR). A total of eight

[11] We decompose the annual change of the DSTI. For this decomposition, we calculate the DSTI for the respective quarters with all the variables using their actual values except the one the impact of which we are interested in. The value of this variable is fixed at the value four quarters before. This way, we estimate the DSTI without the impact of the annual change of the respective variable/factor. The difference between the actual DSTI and the DSTI estimated this way then shows the impact of the annual change of the respective factors.

countries are included for comparison[12]. The household DSR ratio for these countries is accessible on the BIS website[13]. Furthermore, time series data are also available to calculate Macro DSTI since 2003, therefore the period encompassing the Great Financial Crisis as well as the Covid-19 pandemic can be incorporated. For the analysis, we employ the Macro DSTI with net disposable income of only indebted households.

To identify crises periods, we utilise the crises database of the European Systemic Risk Board[14]. The database includes all crisis episodes and episodes of increased financial stress experienced by EU countries with a detailed description of the crises events, beginning and end dates of the crises, crises management policies used and accelerators, i.e. a brief description of the systemic dimension of the crises.

Chart 9 Debt-service behaviour around crises, excluding the Covid-19 pandemic (in %)



Source: NBS, ECB, Eurostat, HFCS, BIS.
Note: horizontal axes show quarters around the crises.

The development of the two indices around the crises periods shares some similarities. When excluding the Covid-19 pandemic (Chart 9), both indices are increasing ahead of the crises, with a more pronounced development of the Macro DSTI. Following the occurrence of a crisis, both indices exhibit a decline, although in some instances this occurs with a certain degree of delay. This may be attributed to the fact that the analysis is limited to the evolution of households' debt service, which may only exhibit a delayed response to the onset of a crisis, particularly in instances where the trigger originates from the financial markets or the non-financial corporate sector.

The development is not so straightforward in case we also include the Covid-19 pandemic (Chart 10). While the Macro DSTI continues to demonstrate a modest increase, the development of the BIS DSR exhibits a more stagnant trajectory. This can be attributed to the fact that, despite being classified by numerous countries as a crisis episode, the negative development was largely driven by supply shocks resulting from social distancing measures (del Rio-Chanona, et al., 2020). Conversely, numerous countries provided households with the option of postponing loan repayments, thereby compensating for the potential negative cash

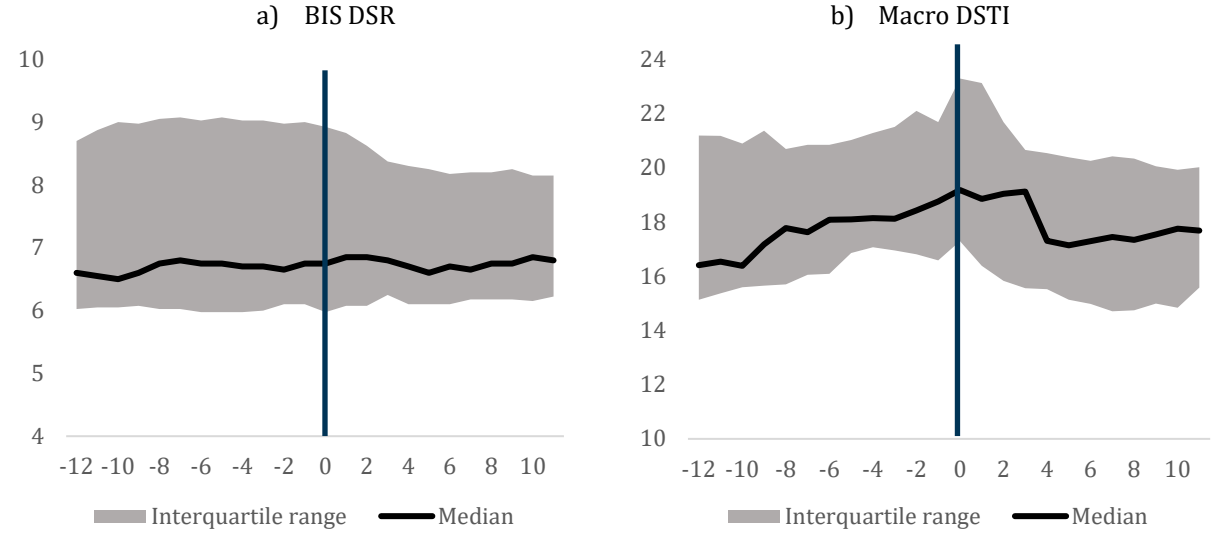
[12] Belgium, Germany, Spain, Finland, France, Italy, Netherlands, Portugal.

[13] Available under the following link: https://data.bis.org/topics/DSR/data.

[14] The database is available on the website of the Board: https://www.esrb.europa.eu/pub/financial-crises/html/index.en.html.

flow that would otherwise have arisen (Cesnak, et al., 2023). Therefore, the official debt-service statistics of households were not significantly affected by the crisis.

Chart 10 Debt-service behaviour around crises, including the Covid-19 pandemic (in %)



Source: NBS, ECB, Eurostat, HFCS, BIS.
Note: horizontal axes show quarters around the crises.

To compare the early warning performances of the two indices, we employ the methodology used in (Drehmann & Juselius, 2012). This entails the utilisation of a signal extraction method over a three-year period, with the objective of minimising the noise-to-signal ratio while identifying a minimum of two-thirds of the crises. As anticipated, the early warning performance of the two indices is found to be highly comparable (Table 1). This is due to the fact that both indices should capture the same trend in the development of the debt service burden of households. Conversely, the Macro DSTI also considers the ratio of indebted households and its evolution over time, which results in a more pronounced development and consequently a lower noise-to-signal ratio than that observed for the BIS DSR. It is, however, important to note that our analysis is limited to the debt service burden of households. It thus follows that these indices can only be employed for the purpose of forecasting periods of financial stress when considered as part of a broader set of indices, which encompass other pertinent aspects of the financial sector and the real economy.

Table 1 Early warning performance of the BIS DSR and Macro DSTI

	BIS DSR		Macro DSTI	
	Excluding Covid-19	Including Covid-19	Excluding Covid-19	Including Covid-19
Threshold	6.1	6.4	18.5	18.3
Share of predicted crises	75%	69%	75%	69%
Noise-to-signal ratio	0.69	0.57	0.46	0.41

6. Conclusions

The debt service to income ratio is a principal indicator of credit risk. While the calculation of DSTI at the level of individual borrowers is relatively straightforward, the same cannot be said for this indicator at the macro or country level. Such an estimation at the country level, however, facilitates cross-country comparisons of the debt burden.

The objective of this paper is to estimate Macro DSTI, or DSTI at the level of selected EU countries for households. The methodology for calculating the debt service ratio at country level in previous studies, like the BIS DSR, is improved in several ways. Firstly, the average maturities of housing loans are estimated using survey data from the HFCS. Secondly, in

consideration of the disparate tax regimes prevailing in different countries, we proceed to estimate the net income of households. Ultimately, the DSTI is estimated for solely indebted households, once more utilising survey data from the HFCS. The estimation of DSTI using the net income of only indebted households in comparison to the gross income of all households results in different outcomes, not only in terms of absolute levels, but also in terms of relative rankings when comparing different countries.

Furthermore, we show that the early warning properties of the Macro DSTI are comparable to those of the BIS DSR. Although both indices demonstrate comparable trends, the Macro DSTI is more efficient, as it also considers the ratio of indebted households and its evolution over time.

While Macro DSTI was stagnating or decreasing in the majority of countries after the global financial crisis, Slovakia exhibited a rapid increase until 2018. During this period, the rising volume of loans was only partially offset by rising income and declining mortgage interest rates. A change in the trend occurred only after the volume of consumer loans started to decrease.

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Appendix 1 Difference between hybrid and amortising loans

In most of countries with interest only loans present, these are either hybrid loans or savings/investment mortgages. In the latter case, debtors must save/invest some amount of money beside monthly payments to pay back the notional amount at maturity. In the former case, the loan is interest only in the first 7 – 10 years and amortising the next (usually) 20 – 25 years so that the whole principal is paid back at maturity.

For an amortising loan, assuming constant monthly payments, this payment can be calculated as

$$P_A = NA\frac{r}{1-(1+r)^{-n}}$$

where P_A is the monthly payment for the amortising loan, NA is the notional amount, r is the interest rate and n is the number of outstanding payments. In case of a hybrid loan with the same maturity n, notional amount and interest rate, with the maturity of the interest only payment $m < n$, the first m interest only payments can be calculated as

$$P_{IO} = NA.r$$

and the amortising payments after the first m payments as

$$P_{IO,A} = NA\frac{r}{1-(1+r)^{-(n-m)}}$$

Interest only payments can be expressed as a function of payments of the amortising loan as

$$P_{IO} = P_A[1-(1+r)^{-1}]$$

The amortising payments of the hybrid loan can be expressed as a function of payments of the amortising loan as

$$P_{IO,A} = P_A\frac{1-(1+r)^{-n}}{1-(1+r)^{-(n-m)}}$$

If we assume such hybrid loans are gradually granted and thus there will be a share of m/n debtors with hybrid loans paying the interest only part and $(n-m)/n$ of debtors paying back the amortising part, the average monthly payment will be

$$\frac{m}{n}P_{IO} + \frac{n-m}{n}P_{IO,A} = P_A\frac{1-(1+r)^{-n}}{n}\frac{n-m(1+r)^{-(n-m)}}{1-(1+r)^{-(n-m)}}$$

Thus, the difference between the monthly payment from the hybrid loans and the amortising loans will depend on the maturity of the hybrid loan, the maturity of the interest only part and the interest rate. As the notional amount of the hybrid loan will be paid back in a shorter period (assuming equal maturity of both the hybrid and amortising loan), the average monthly payment of a hybrid loan will be larger than the payment for the amortising loan. However, assuming interest rates ranging from 1 to 4.5% p.a., possible maturity of 15, 20, 25 or 30 years and the possible interest only period of 5 or 10 years, this difference ranges from 2 to 16% (Chart 11). Also given the tax deductibility of such hybrid loans, the difference between the average monthly payment will be relatively small at the country level.

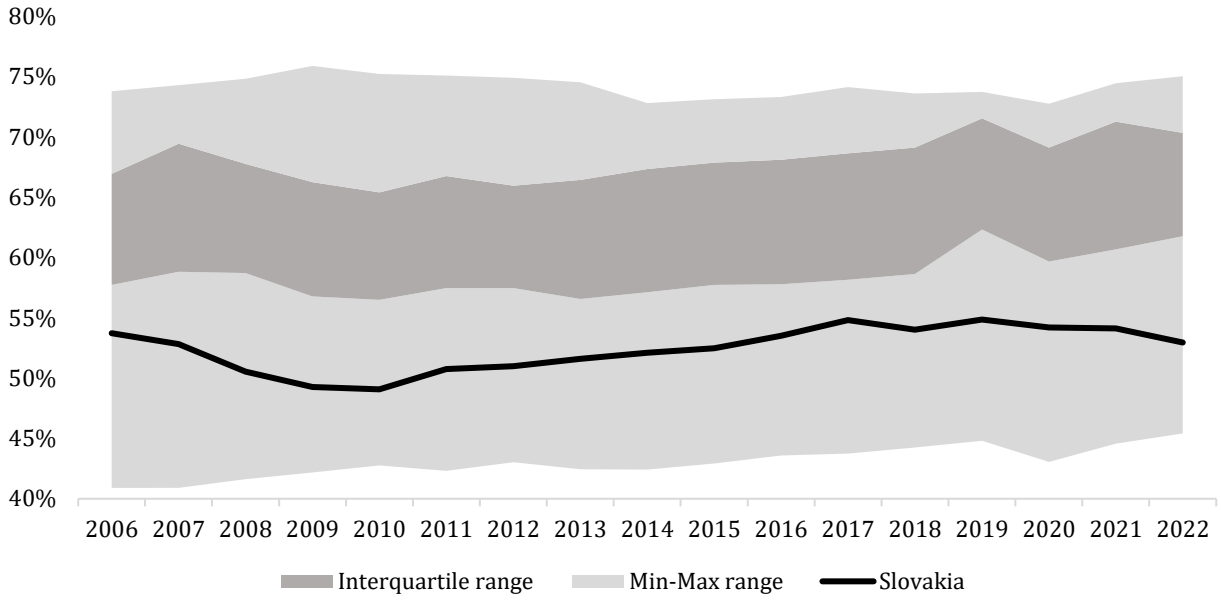
Chart 11 Share of average monthly payments of a hybrid loan on monthly payments of an amortising loan

Source: own calculations.
Notes: the share was estimated using interest rates ranging between 1% and 4.5%, maturity of 15, 20, 25 or 30 years and interest only period of 5 or 10 years. Y-axes display the share of the average the monthly payment of a hybrid loan on the monthly payments of an amortizing loan. E.g., 1.16 means the payment for the hybrid loan is 16% higher than the payment for the amortizing loan. This share was estimated for different interest rates, maturities, and interest only periods. We show the share for all combinations in ascending order; therefore we do not include x-axes.

Appendix 2 Wages and salaries vs gross disposable income

Disposable income includes also other sources of income on top of wages and salaries. In general, the share of gross wages and salaries is between 40% and 75% of the gross disposable income in the respective countries. In Slovakia, the share fluctuates slightly above 50%, without any huge changes over the period under consideration.

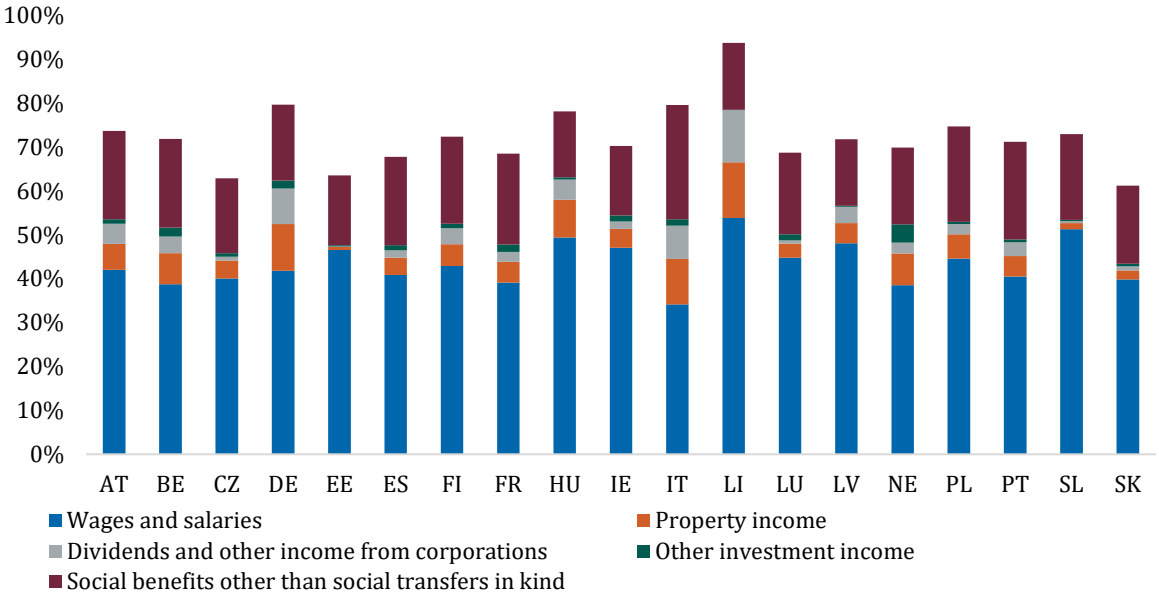
Chart 12 Share of wages and salaries in the gross disposable income



Source: NBS, Eurostat

Beside gross wages and salaries, social benefits (e.g., payments due in respect of sickness or unemployment) have the second largest share in the total disposable income. Other income is related to property income, dividends from shares, or other investment income, but these sources vary largely between countries.

Chart 13 Relative importance of different income sources, 2022

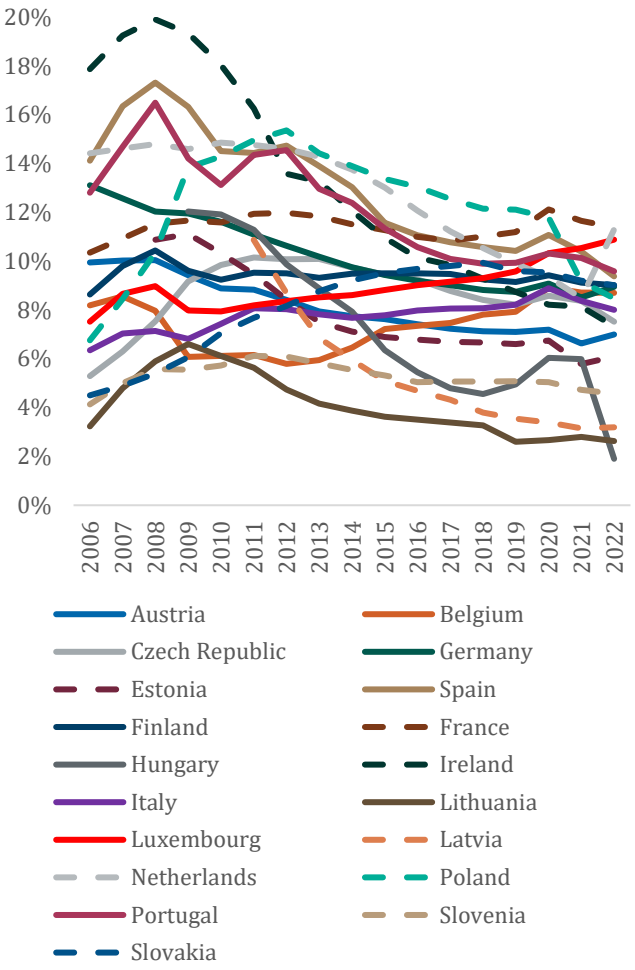


Source: NBS, Eurostat
Note: Shares in primary income

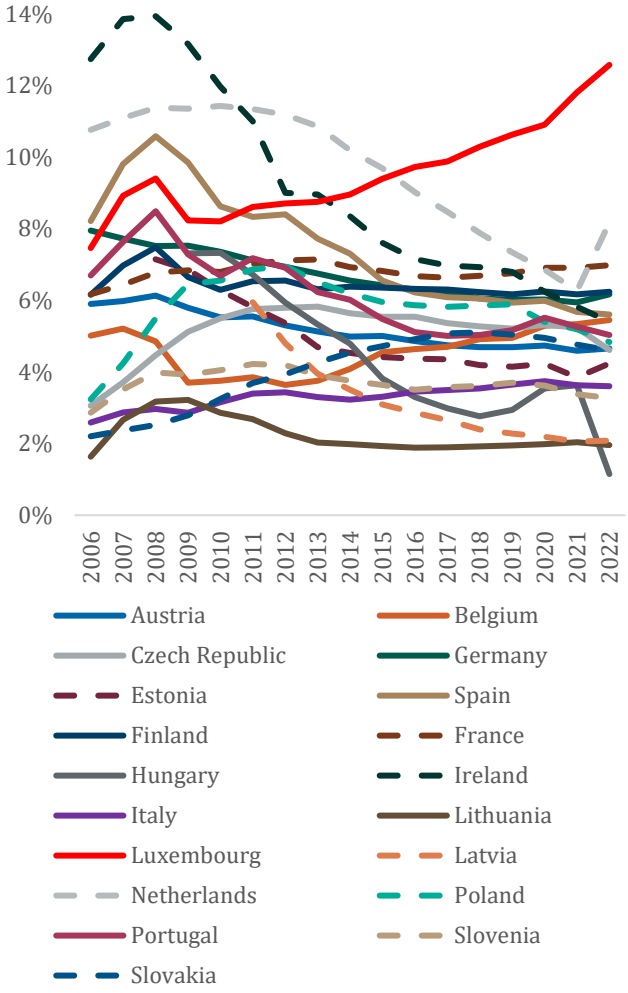
Appendix 3 Macro DSTI at the level of respective countries

Chart 14 Development of the Macro DSTI since 2006 – individual countries

a) denominator: wages and salaries



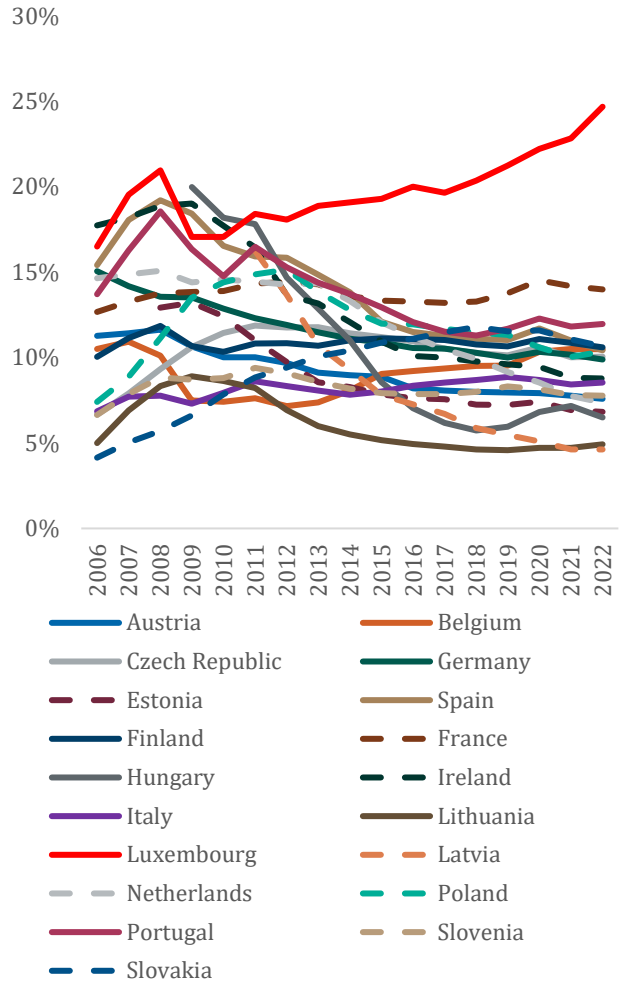
b) denominator: gross disposable income



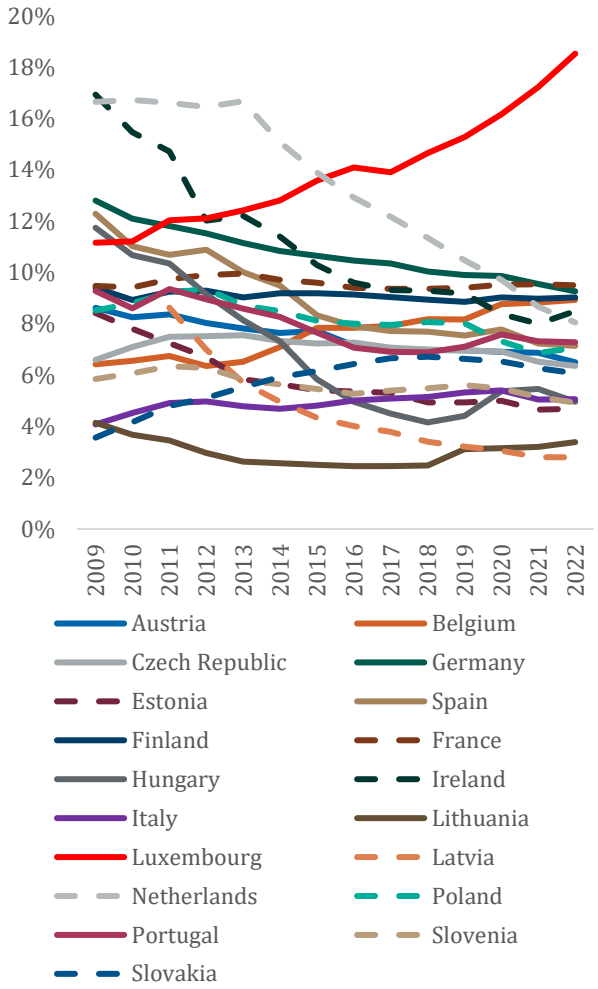
Source: NBS, ECB, Eurostat, HFCS

Chart 15 Estimation of Macro DSTI using net wages and net disposable income – individual countries

a) denominator: net wages and salaries



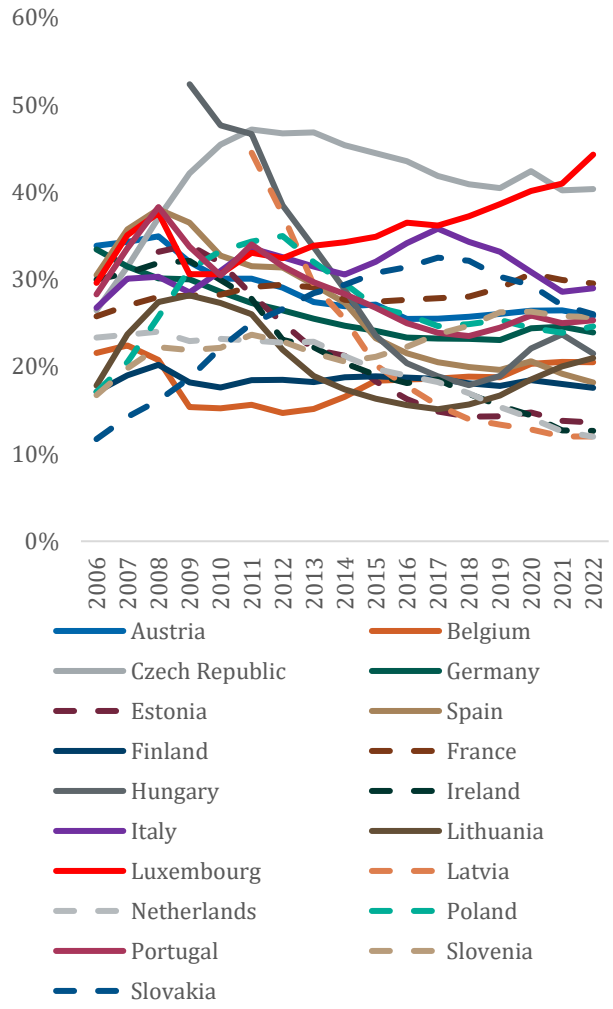
b) denominator: net disposable income



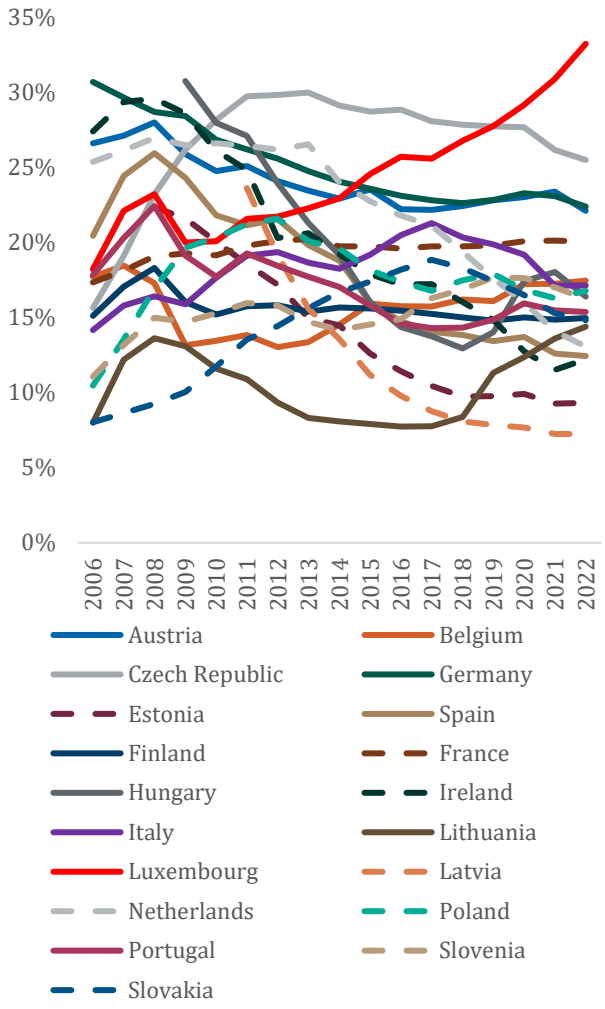
Source: NBS, ECB, Eurostat, HFCS

Chart 16 Estimation of Macro DSTI for only indebted households – individual countries

a) denominator: net wages and salaries

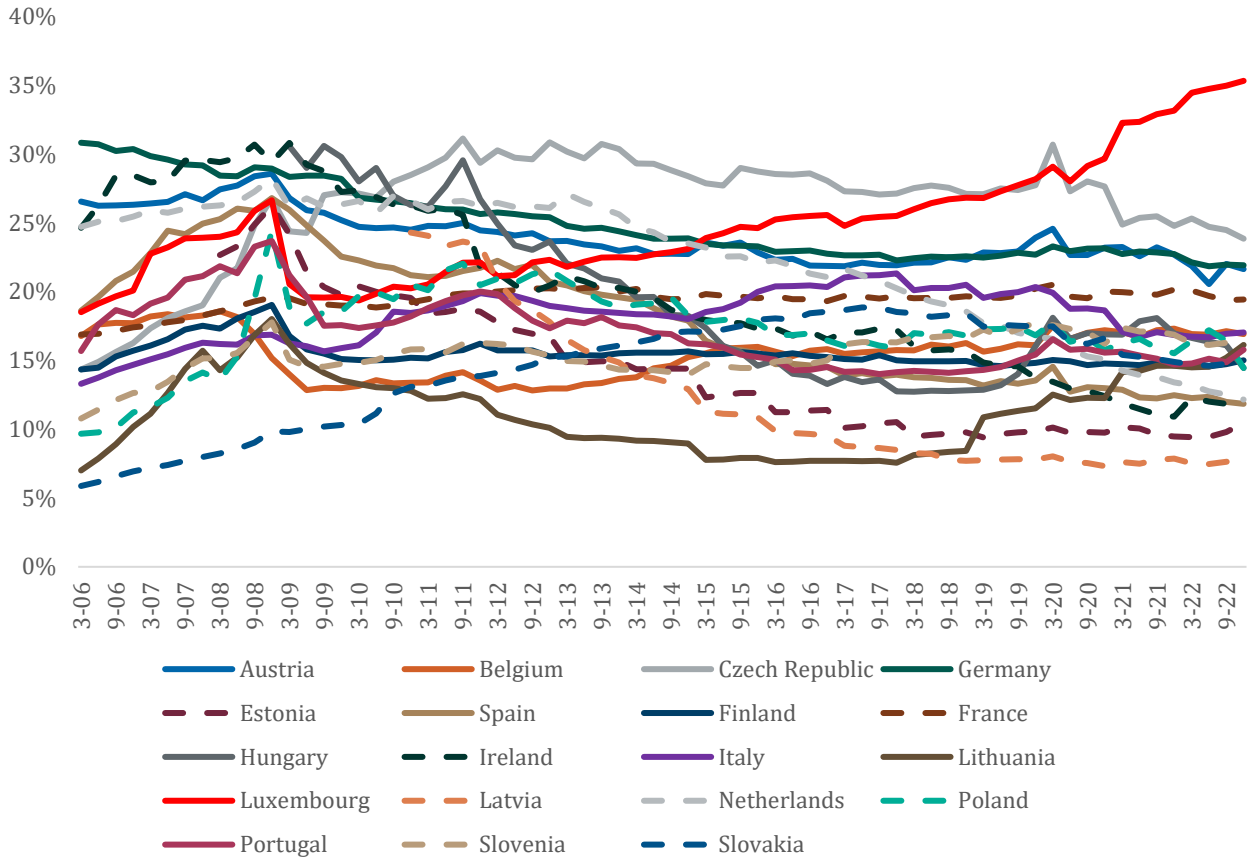


b) denominator: net disposable income



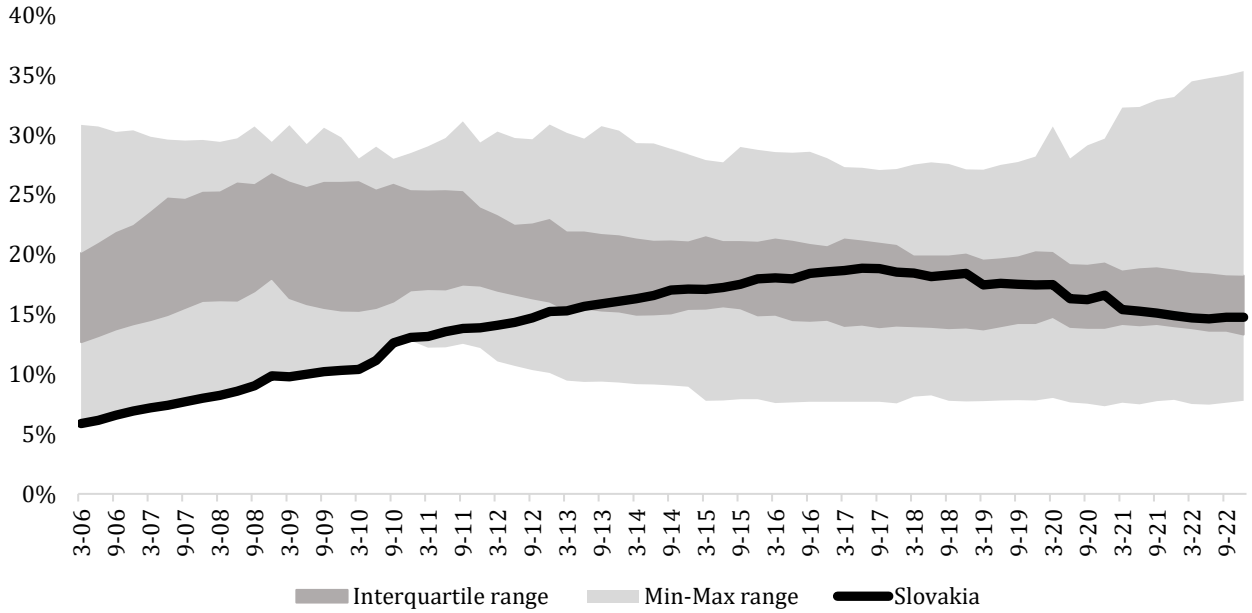
Source: NBS, ECB, Eurostat, HFCS

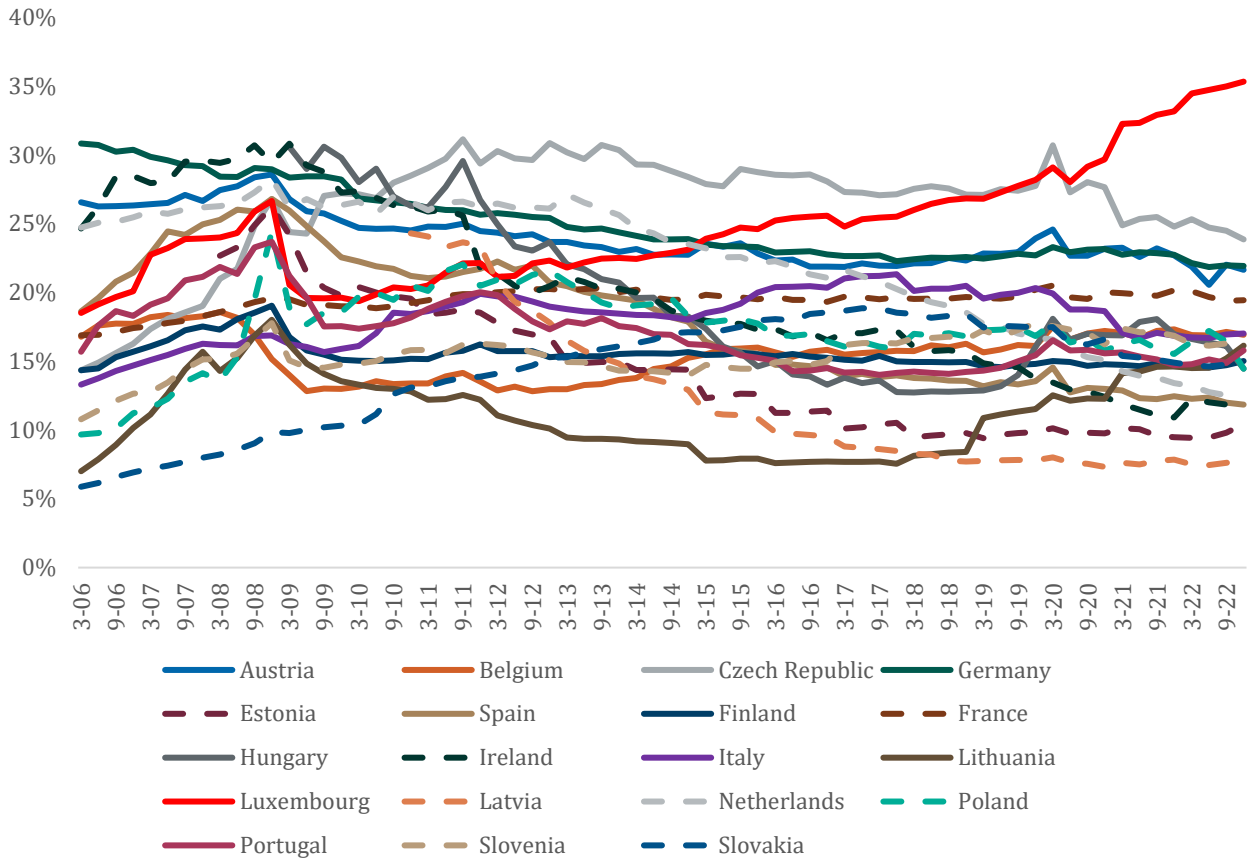
Appendix 4 Estimation of Macro DSTI using net disposable income of only indebted households – quarterly data for individual countries



Source: NBS, ECB, Eurostat, HFCS

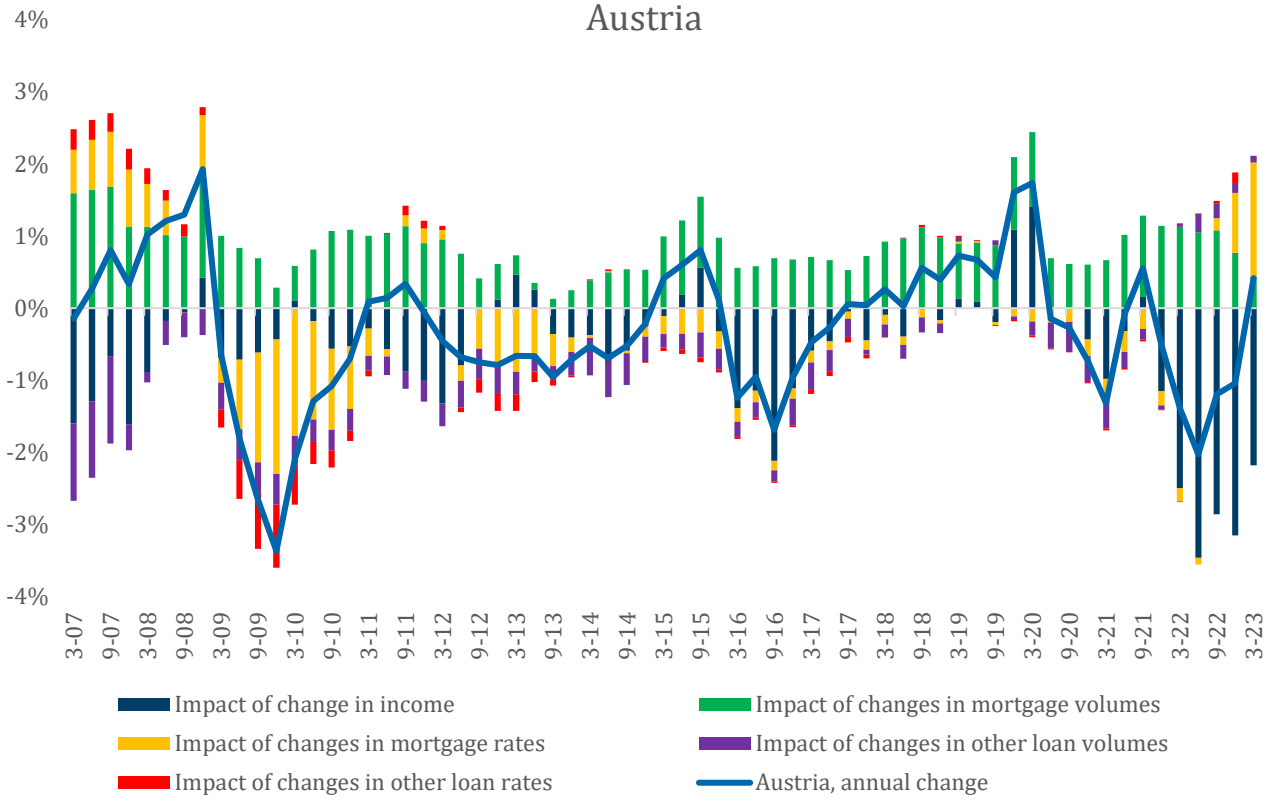
Appendix 5 Estimation of Macro DSTI using net disposable income of only indebted households – equal maturities



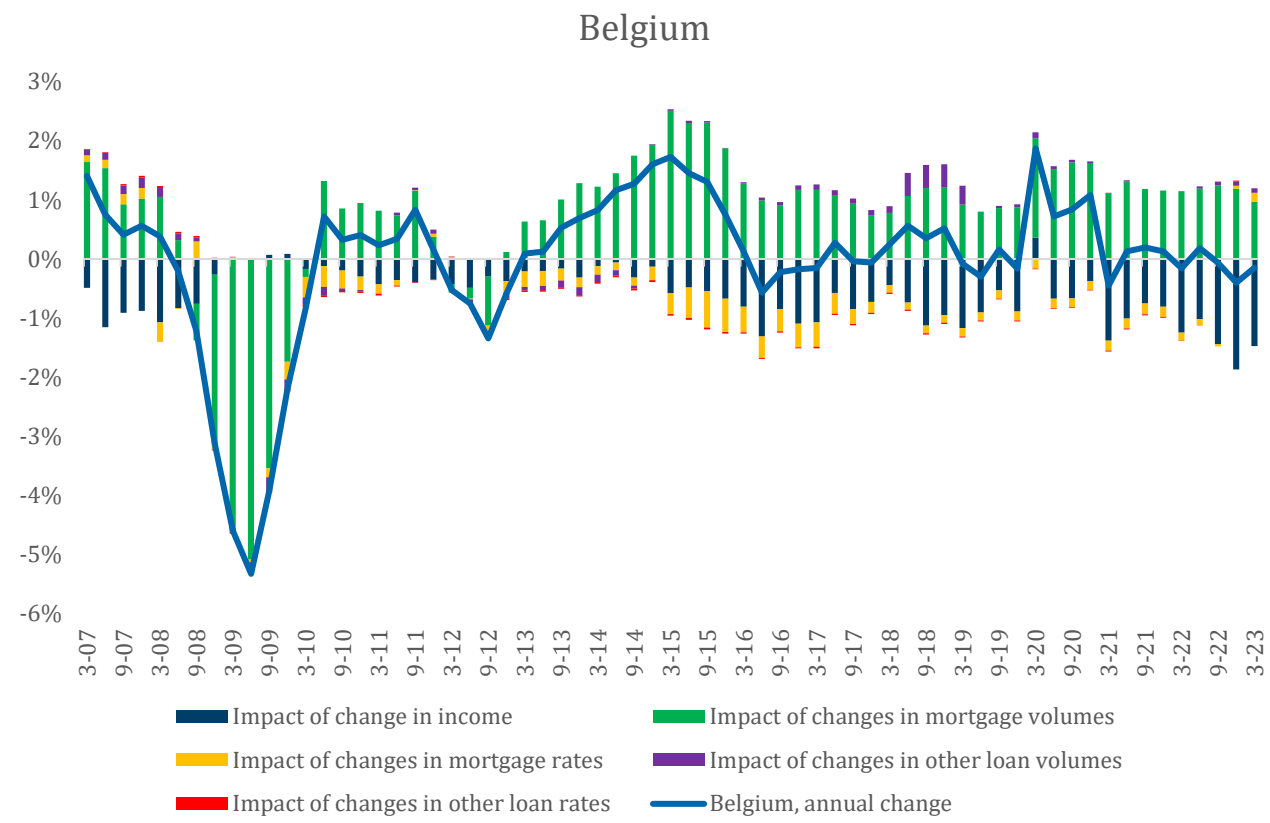


Source: NBS, ECB, Eurostat, HFCS

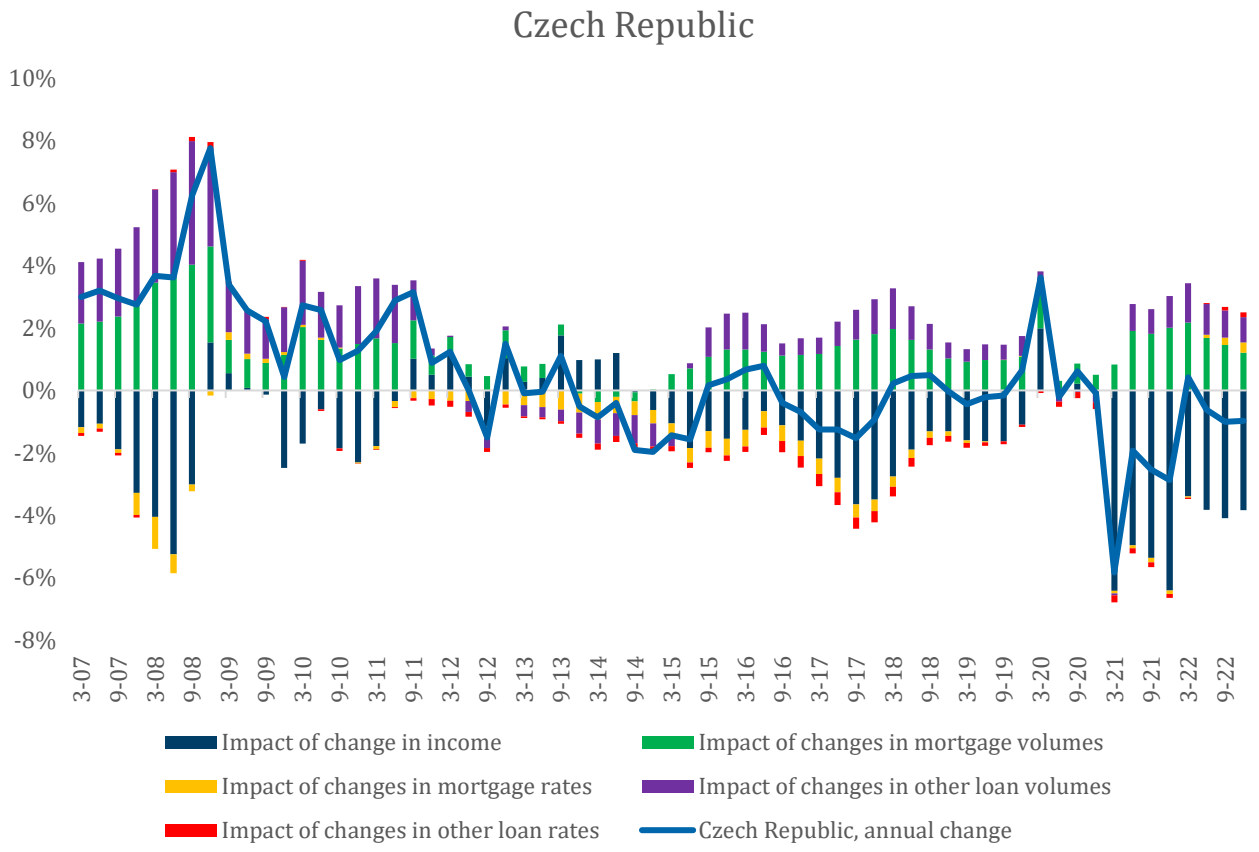
Appendix 6 Decomposition of the DSTI change – Individual countries



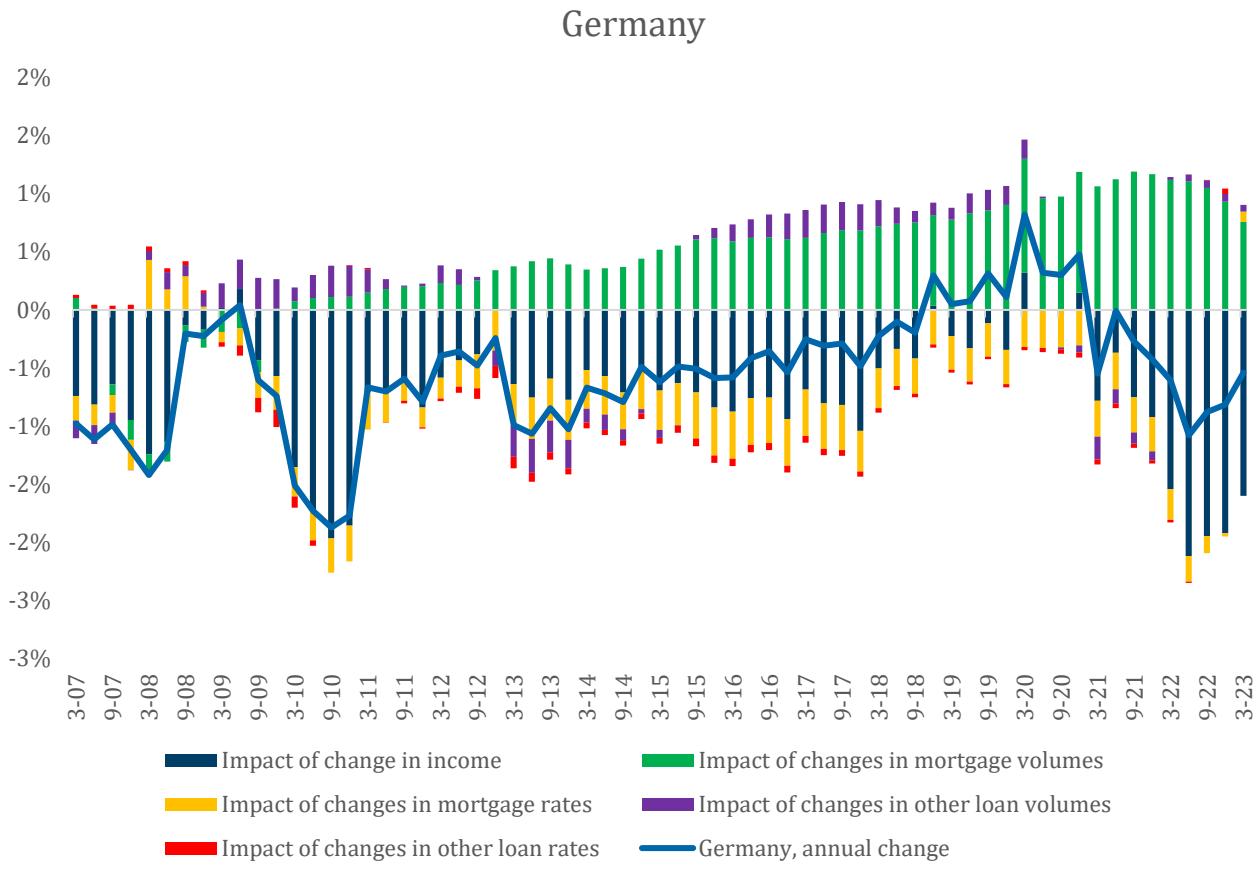
Source: NBS, ECB, Eurostat, HFCS



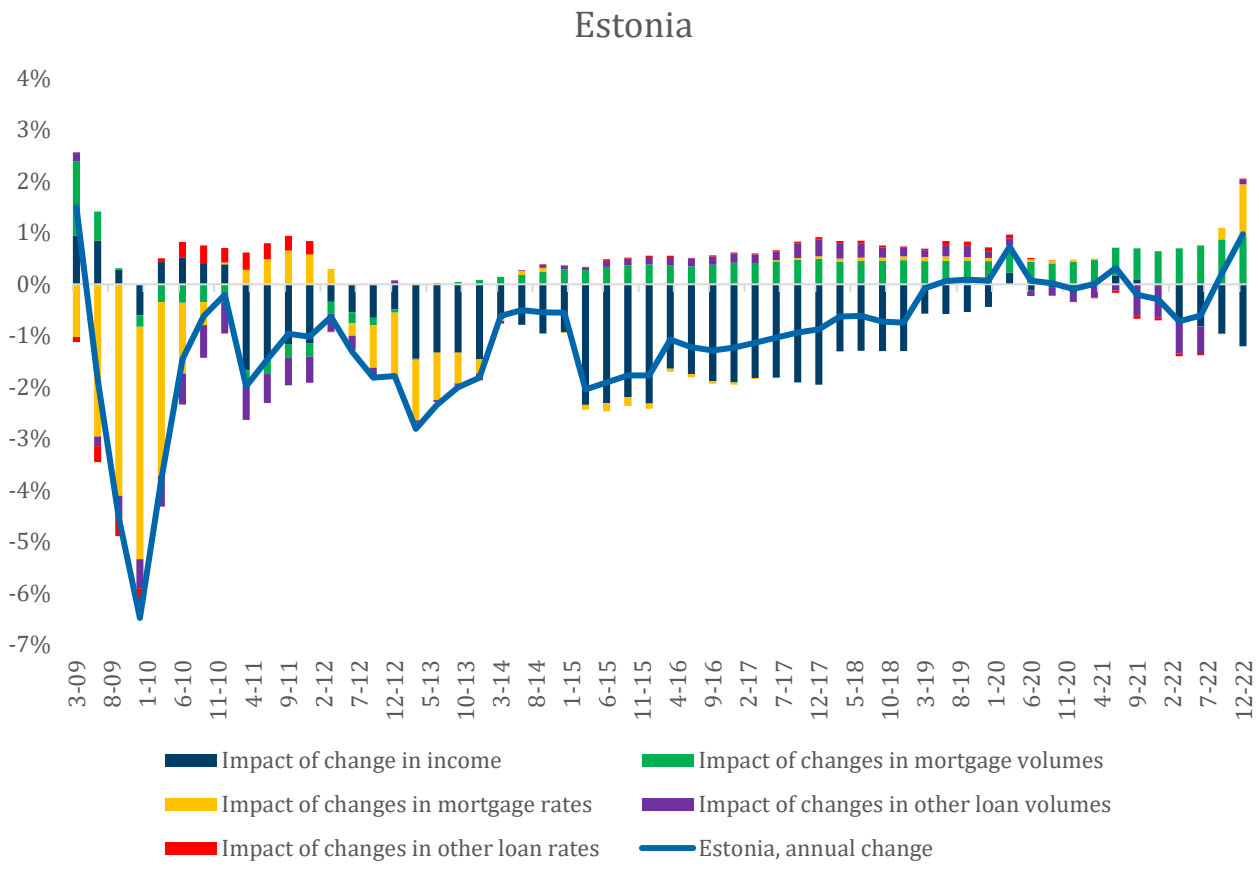
Source: NBS, ECB, Eurostat, HFCS



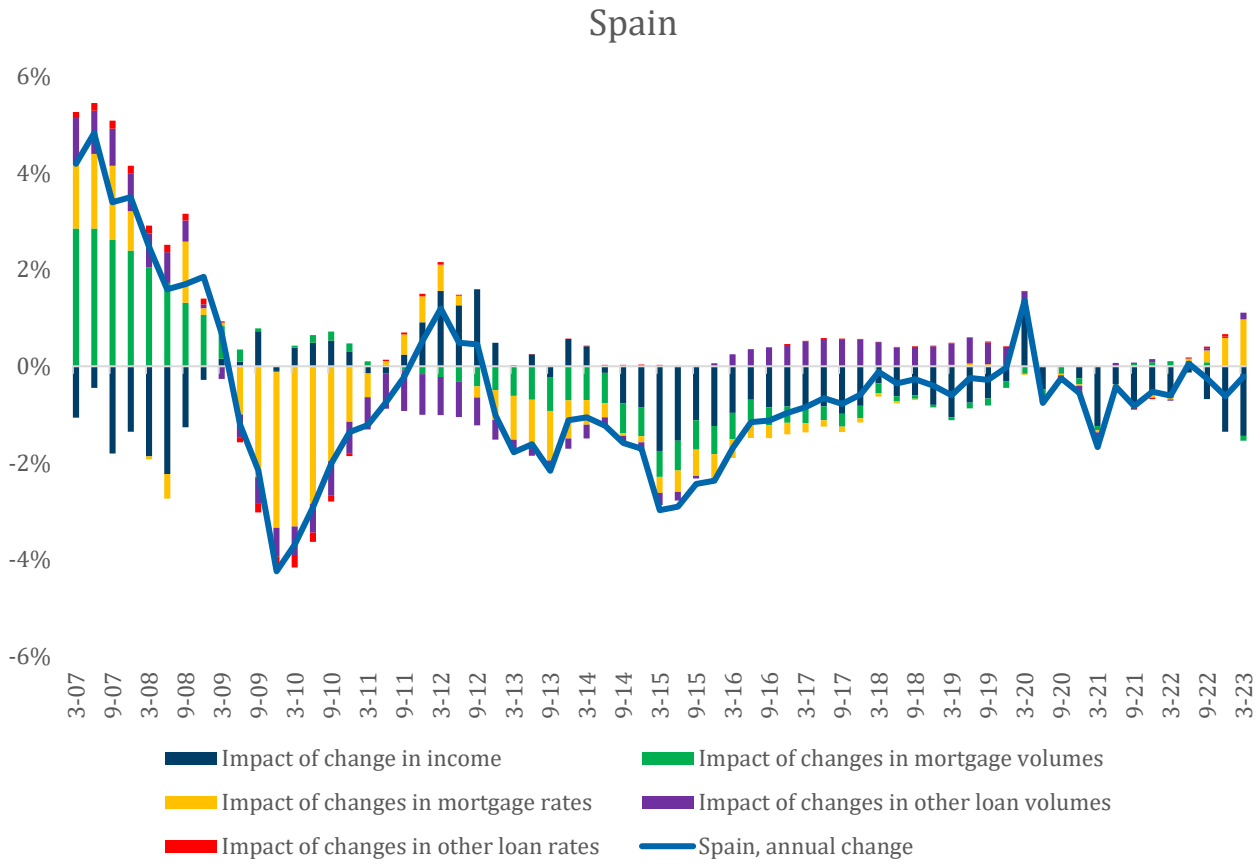
Source: NBS, ECB, Eurostat, HFCS



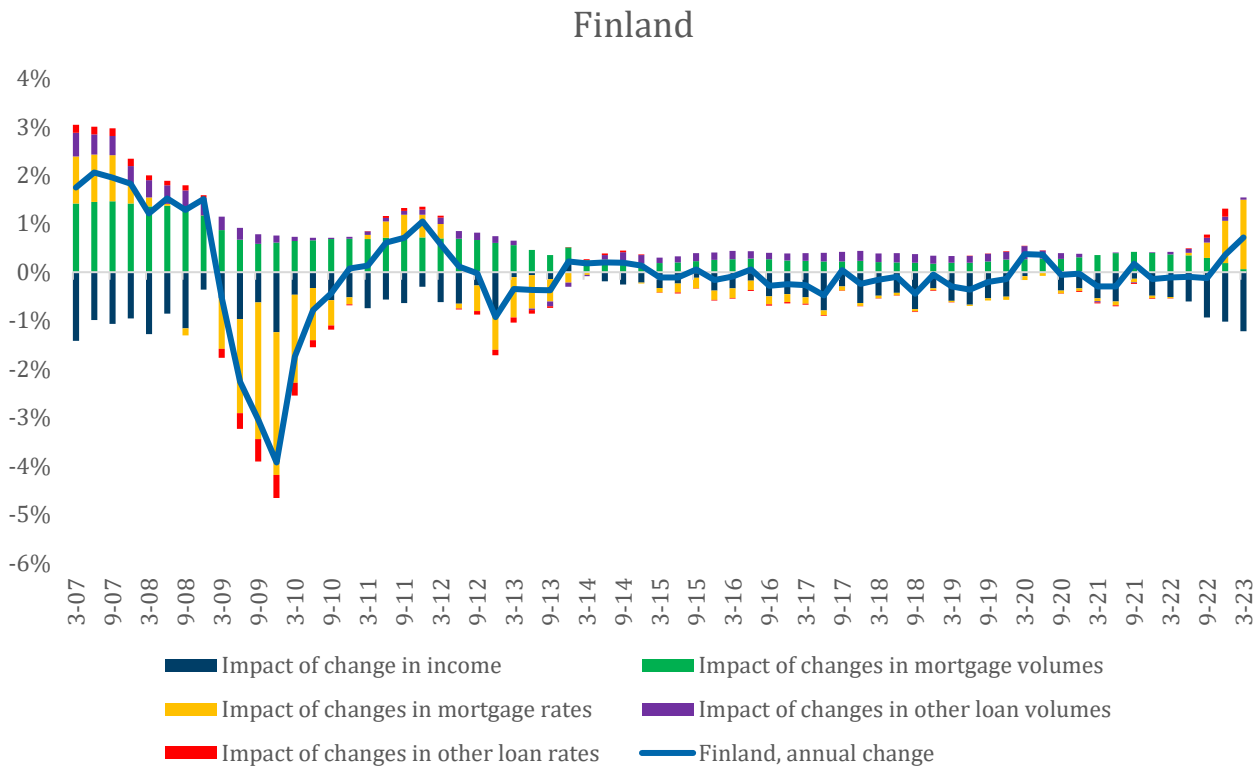
Source: NBS, ECB, Eurostat, HFCS



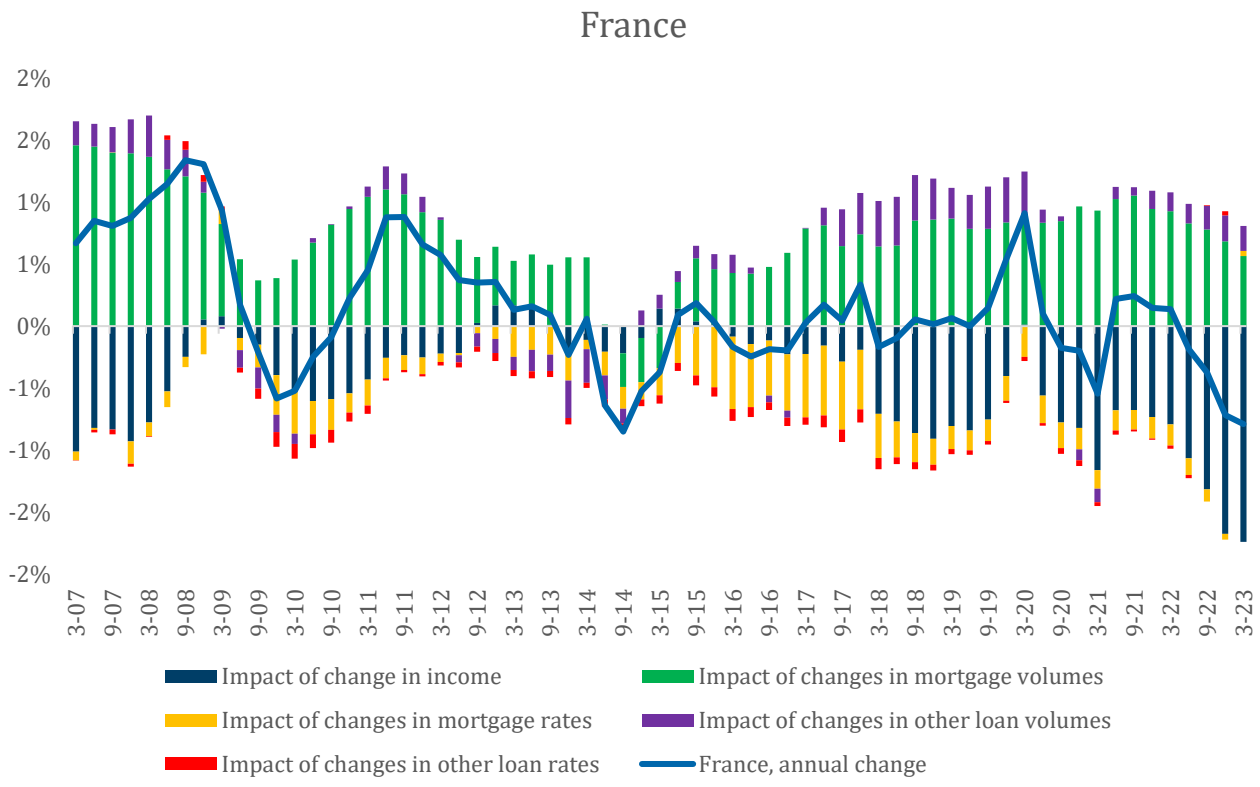
Source: NBS, Eurostat, HFCS



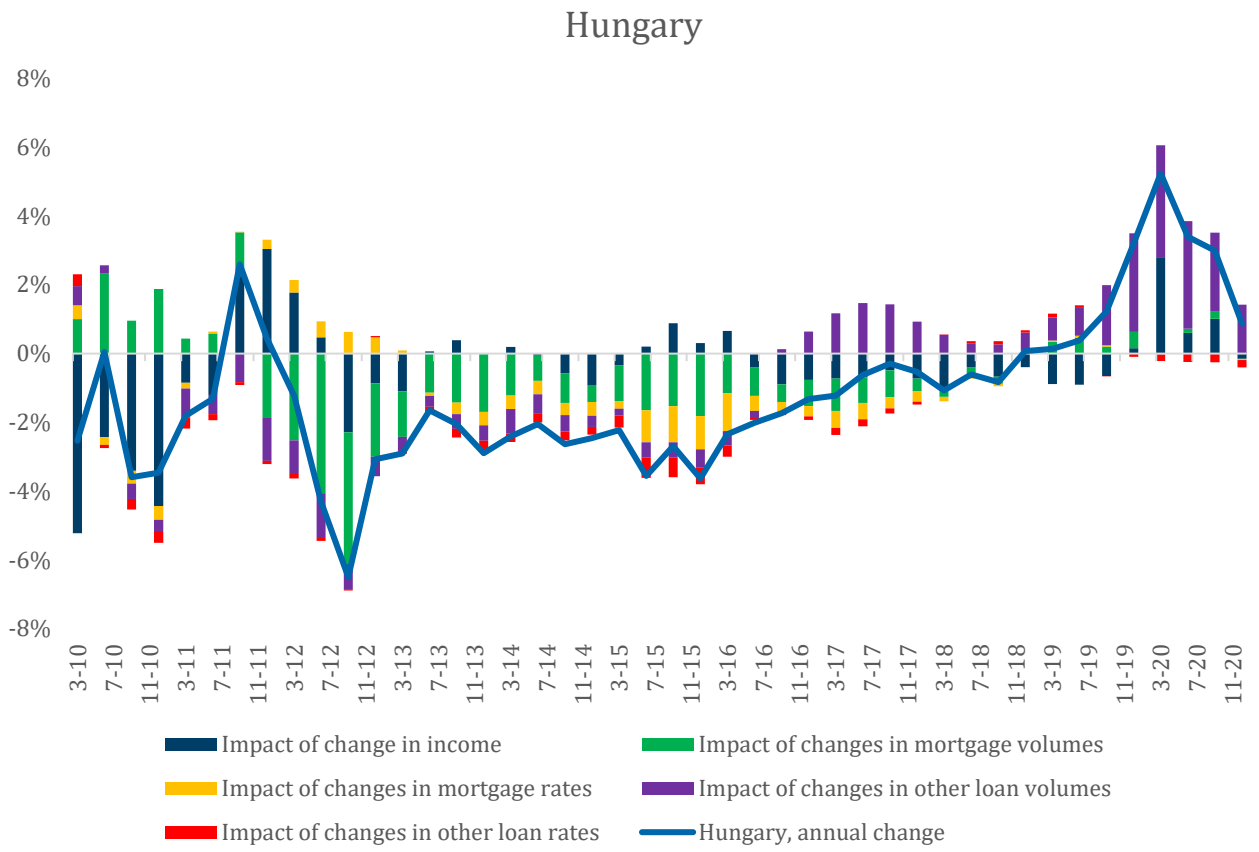
Source: NBS, ECB, Eurostat, HFCS



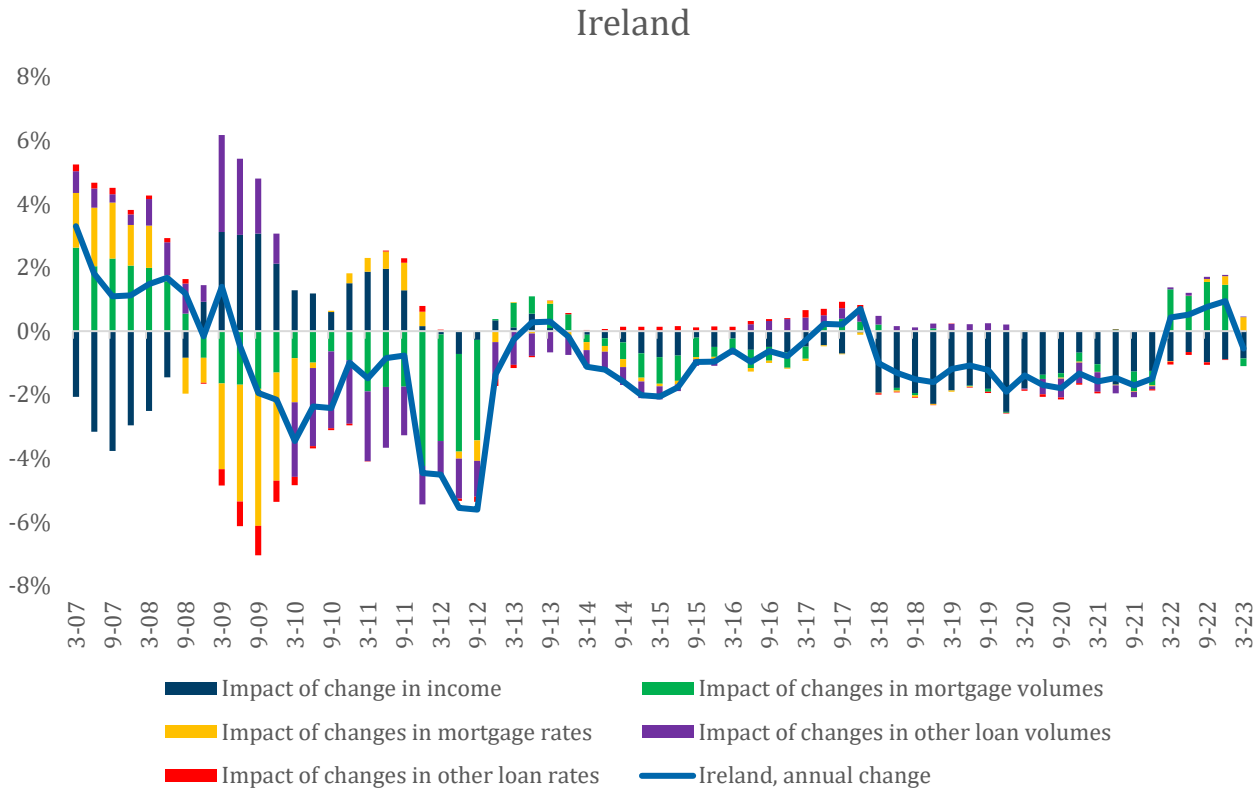
Source: NBS, ECB, Eurostat, HFCS



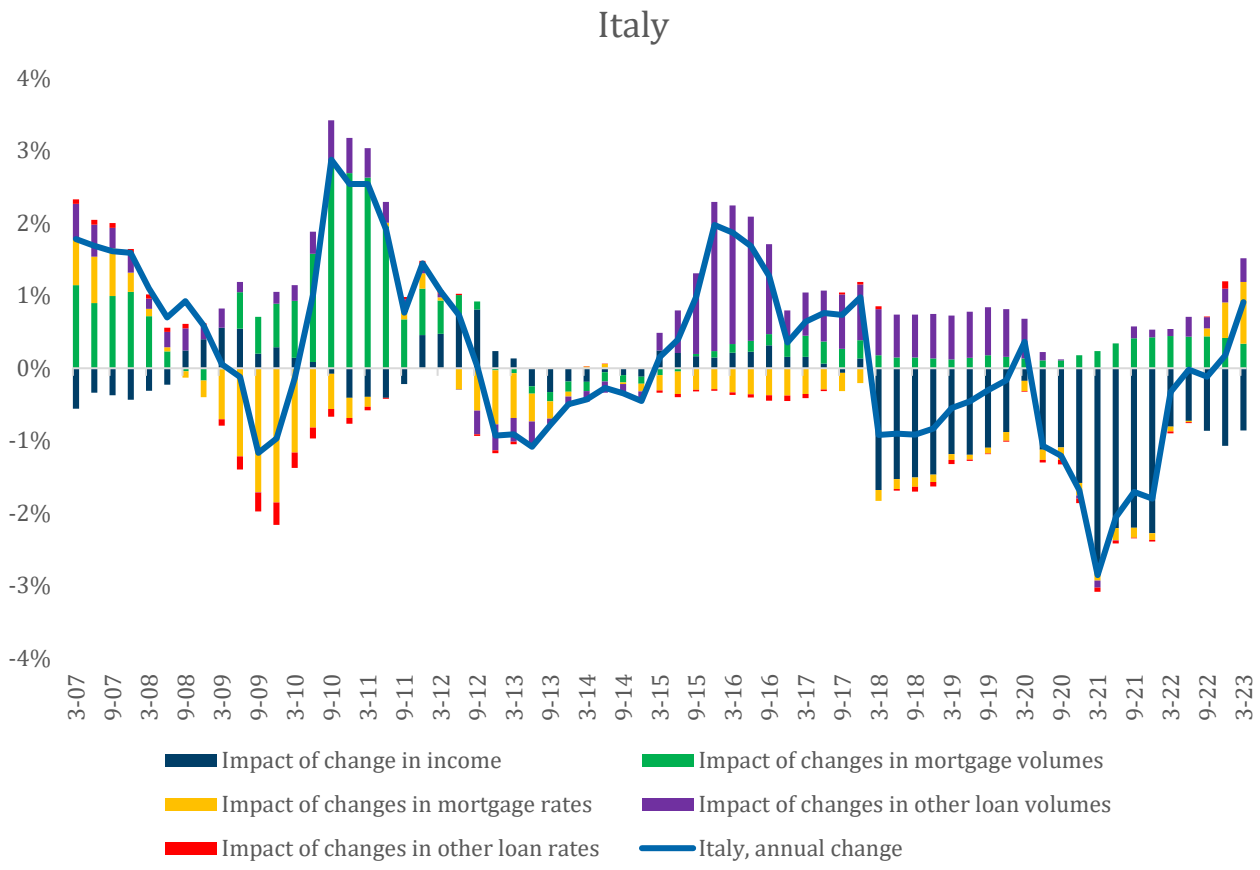
Source: NBS, ECB, Eurostat, HFCS



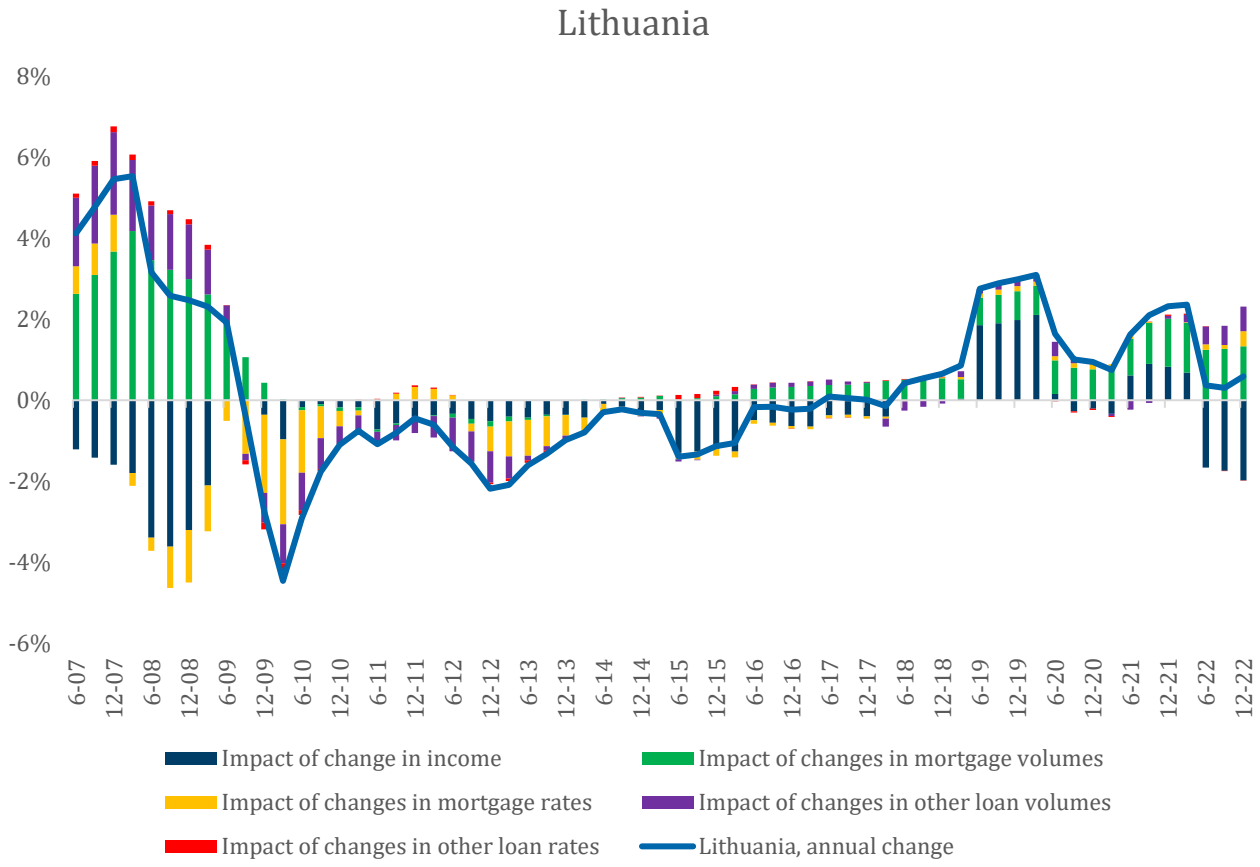
Source: NBS, ECB, Eurostat, HFCS



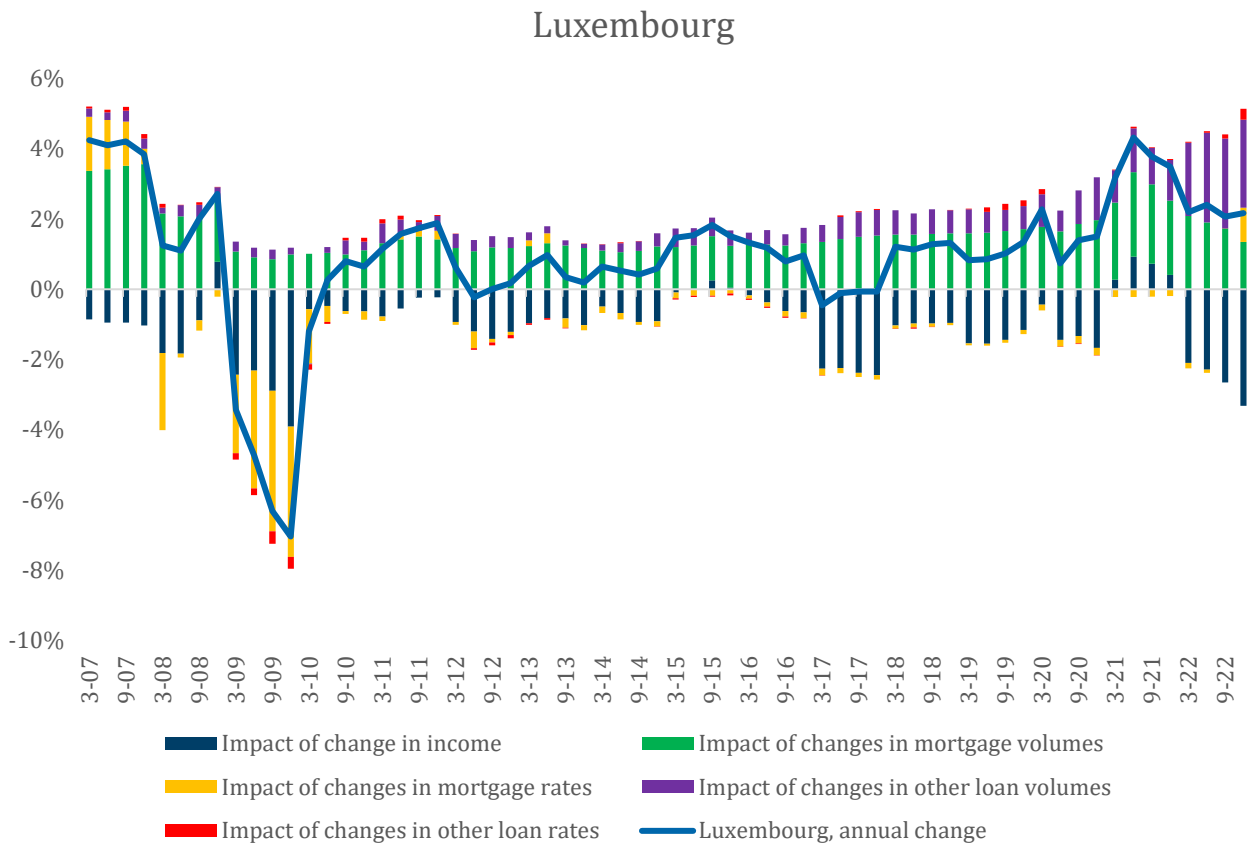
Source: NBS, ECB, Eurostat, HFCS



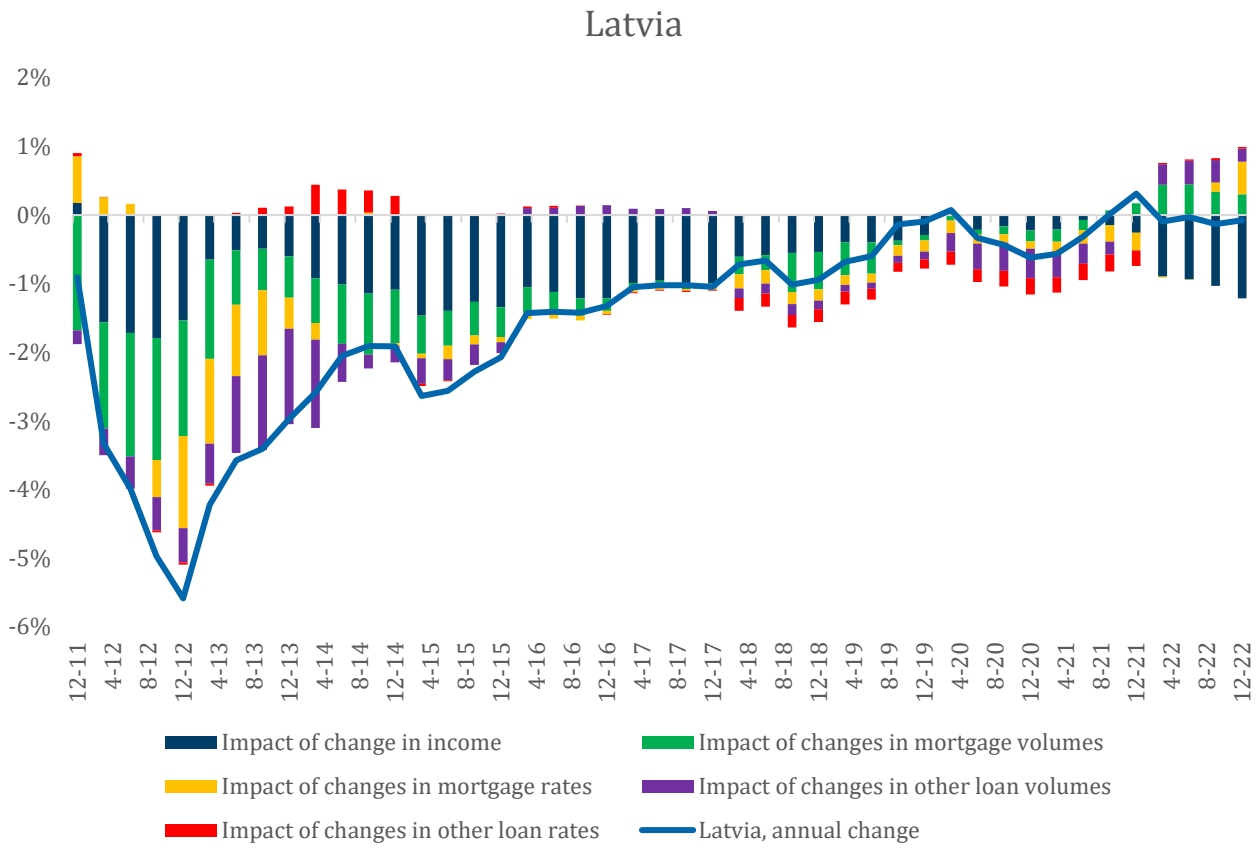
Source: NBS, ECB, Eurostat, HFCS



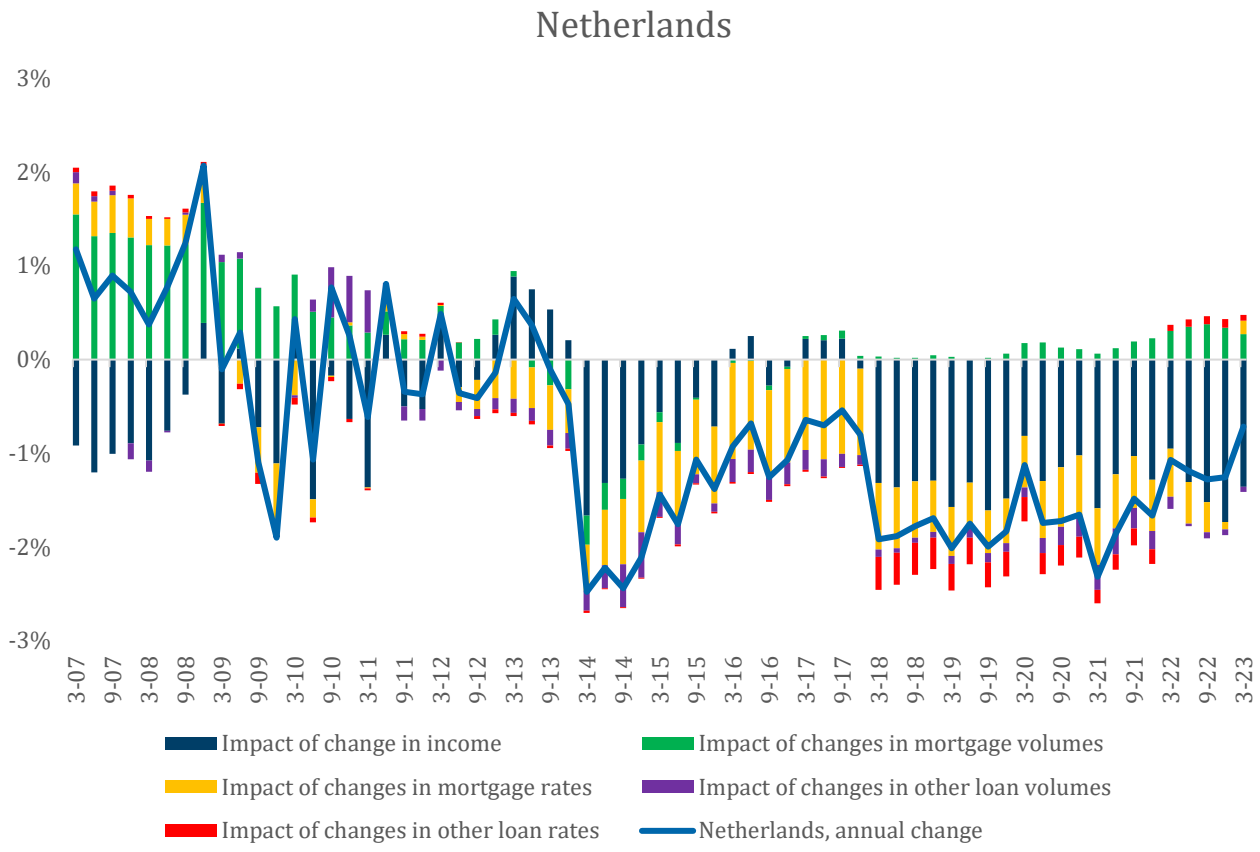
Source: NBS, ECB, Eurostat, HFCS



Source: NBS, ECB, Eurostat, HFCS



Source: NBS, ECB, Eurostat, HFCS



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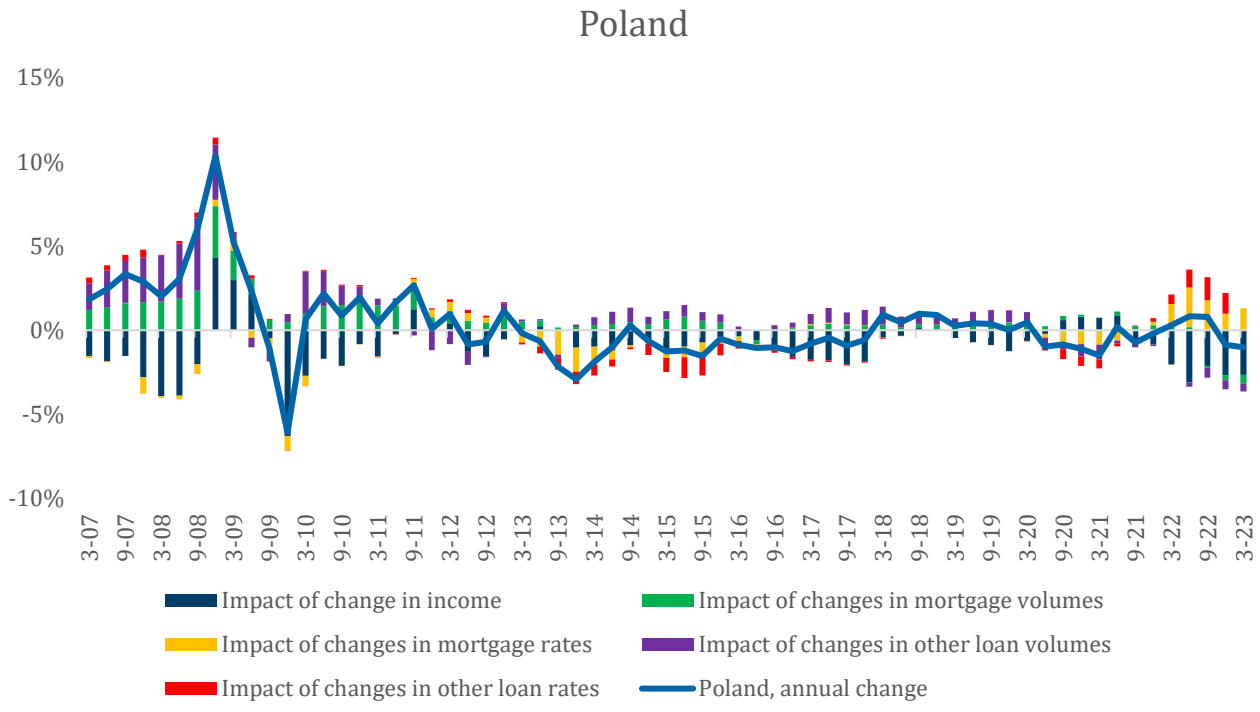
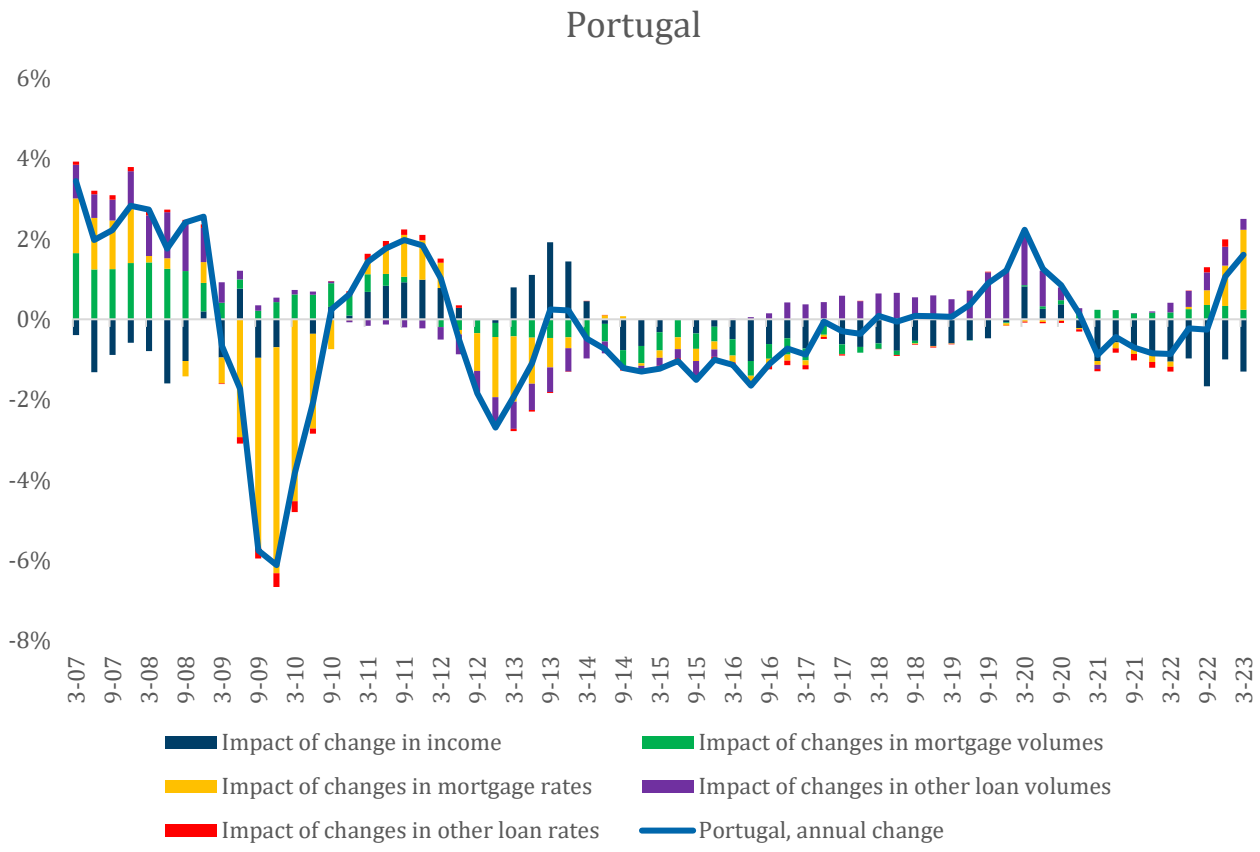
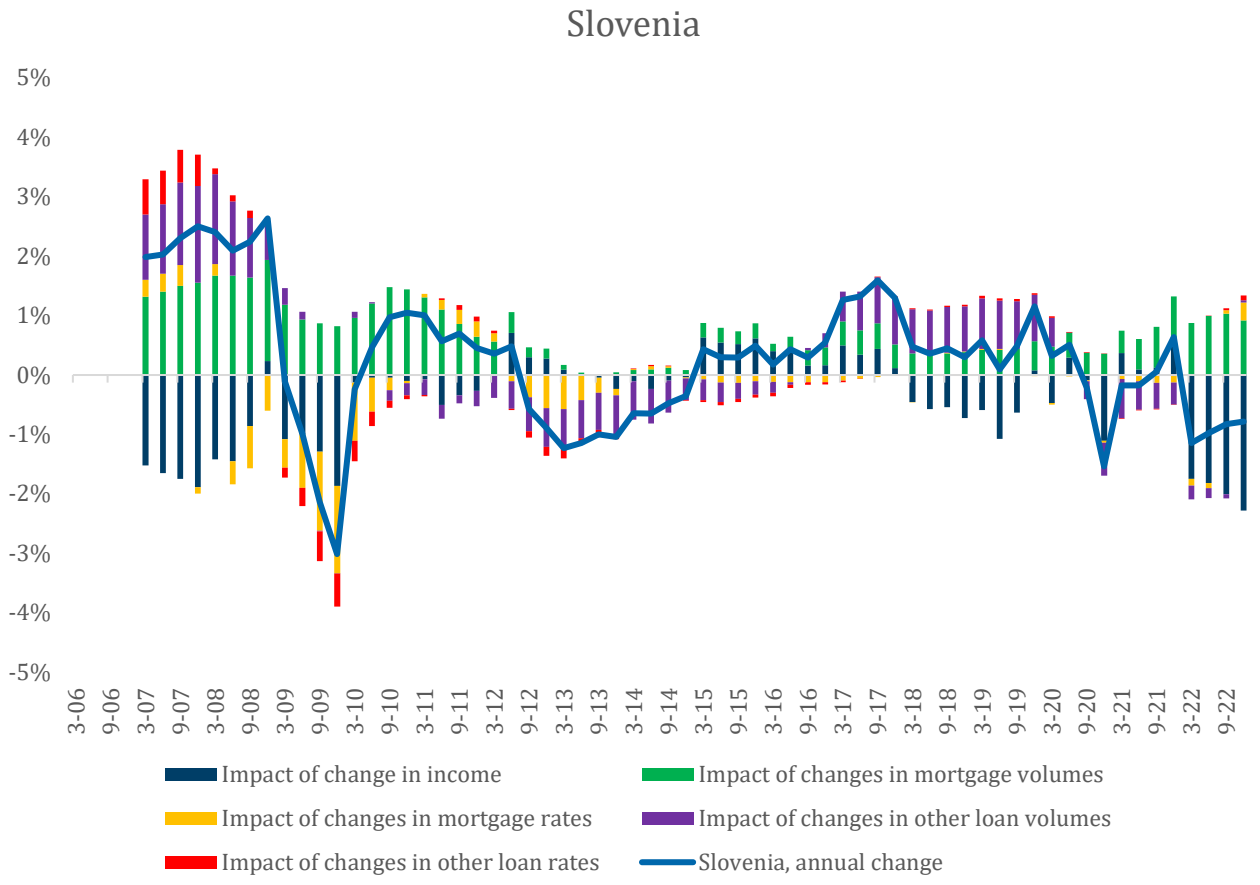


Source: NBS, ECB, Eurostat, HFCS



Source: NBS, ECB, Eurostat, HFCS



Source: NBS, ECB, Eurostat, HFCS