Why is the LSTI ratio increasing? Explaining factors of synthetic LSTI dynamics

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Abstract

In this paper, we focus on the analysis of the drivers of LSTI ratio dynamics. Against this backdrop, we try to bridge this gap by introducing an average synthetic LSTI calculation and examine how various factors affect the LSTI ratio of borrowers that took out consumer and housing loans in Slovenia based on monthly frequency data spanning from the beginning of 2020 to the end of 2023. We note that the general growth of the incomes of consumers who took out loans inhibited the growth of the average LSTI ratio. Factors affecting the LSTI ratio had an offsetting effect on the LSTI ratio of consumers who took out a consumer loan, while factors affecting the LSTI ratio caused an increase in the LSTI ratio of consumers who took out a housing loan. One of the more important factors that influenced the growth of the LSTI ratio of consumers who took out a housing loan was the increase in the interest rate for housing loans.

Keywords: Macroprudential policy, LSTI Ratio, Borrower-Based Measures.

JEL Classification: C10, E58, G51.

*The views presented herein are those of the authors and do not necessarily represent the official views of the Banka Slovenije and/or of the Eurosystem.

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1 Introduction

Financial systems are per se exposed to various cyclical and structural systemic risks, which may be a consequence of various types of economic shocks. That said, with the help of various economic policies, for instance the macroprudential policy, the relevant supervisory institutions try to mitigate the effects of financial cycles and increase the resilience of the financial systems that they supervise. In order to do so, the relevant supervisory institutions have to conduct the macroprudential policy by successfully monitoring and analysing the cyclical and structural systemic risks and estimate the effectiveness of the macroprudential instruments and measures that have been or are planned to be implemented.

Depending on the specific macroprudential policy in mind, policy-makers have a wide array of macroprudential instruments at their disposal that they can implement (Galati and Moessner 2013). For instance, in the real estate markets, limiting and capping loan-to-value (LTV) and debt service-to-income (DSTI) ratios are the predominant types of macroprudential instruments. Both instruments target the demand side of the banking sector by limiting the highly leveraged households from taking on excessive loans. Binding caps on these type of ratios can tighten the borrowing constraints of indebted households. In turn this may consequently lead to an aggregate reduction in housing loans and residential real estate demand, and ultimately to a decrease in house prices.

Our paper contributes to a strand of literature that studies the effectiveness of various types of macroprudential policy instruments, more precisely the borrower-based measures (BBMs). For instance, Dietsch and Welter-Nicol (2014) use a housing loan-level database to demonstrate the efficiency of credit standards that constrain households' indebtedness. They find that the utilization of the LTV and DSTI ratios combination rather than the use of each ratio separately helps to maintain the total portfolio credit risk under check. Similar was done by Hodula et al. (2022), as they study the effects of regulatory recommendations concerning maximum LTV, DSTI and debt-to-income (DTI) ratios on new loans secured by residential property. Franz (2020) uses a structural approach with a structural VAR model that estimates the effects of binding LTV and DSTI ratios. Futher on, Gregori and Ramos (2024) study the effects of macroprudential (and monetary) shocks on key macroeconomic variables via micro-founded intensity indicators, indicating capital borrower-based measures implementation in the case of Portugal. Bańbuła et al. (2016), on the other hand, focus on the DSTI type of measures and provide a model for calibration of DSTI/DTI limits. Based on Household Finance and Consumption Survey (HFCS) data, Gross and Población (2017) develop an integrated micro-macro model framework that is used for scenario and sensitivity analyses with respect to the drivers of households' income, expenses and asset values and the structure of their balance sheet.[1] De Haan and Mastrogiacomo (2019) conclude that the LTV/DSTI ratios affect the incidence of possible non-performance of loans. Dirma and Karmelavičius (2023) express doubt in the effectiveness of macroprudential toolkits' ability to contain excessive housing loans growth, depending also on other factors, such as a low interest rate environment.

Other studies that are worth mentioning, such as Martins et al. (2021), discuss the appropriate policy approaches to the dynamics of different macroeconomic developments (in their case the relevance of housing markets). Požlep (2023) studies the impact of loan-specific and time-varying bank factors (for instance loan amount, maturity, interest rate type, presence of loan security, DSTI ratio, etc.) on the interest rate spread of new loans in Slovenia. Along these lines, Teixera and Venter (2021) estimate the positive relationship between the tightness of macroprudential policy and the growth in savings in households. Further on, Valderrama (2023) tries to set macroprudential policy tools in response to housing-related systemic risk, which include design solutions to avoid unintended consequences during a tightening phase and navigating the trade-offs between managing the build-up of vulnerabilities.

However, little has been done in the direction of determining how the endogenous factors, which are used to calculate the LSTI ratio, have influenced this ratio for borrowers.

[1] See the similar analysis based on the same model on Slovenian data in Banka Slovenije's Financial Stability Review in Banka Slovenije (2024).

Against this backdrop, Bandoni et al. (2024) find that LSTI increases depend on the mortgage loan characteristics, but their study is done on EA data. Less work has been done in the case of Slovenia. In this paper, we try to bridge this gap by introducing a synthetic LSTI calculation and examine how the factors affecting the LSTI ratio affected the LSTI ratio of Slovenian borrowers that took out consumer or housing loans.

The results of the analysis show that the increase in the average loan amount of consumer loans has the strongest positive effect on the synthetically calculated LSTI ratio of borrowers who took out a consumer loan, ceteris paribus. Other factors affecting the LSTI have a smaller effect on the synthetically calculated LSTI ratio of borrowers who took out a consumer loan. In fact, the increase in the average interest rate for consumer loans has the smallest impact on the synthetically calculated LSTI ratio of borrowers who took out a consumer loan. While the increase in market interest rates has had a positive effect on the LSTI ratio of borrowers who took out a consumer loan mainly in the second half of 2022, the effect was, broadly speaking, rather subdued, due to the limited increase of the average interest rate of consumer loans. The increase in the average maturity of consumer loans had a negative impact on the LSTI of borrowers who took out consumer loans; however, due to the maturity limits set by the macroprudential regulation, the extension of the loan maturity to reduce monthly instalments and thus the LSTI ratio is limited as well. The increase in the average income of the borrowers who took out a consumer loan, however, offsets the increase of the synthetically calculated LSTI ratio. We conclude that the factors affecting the LSTI ratio of borrowers who took out a consumer loan are more or less levelled off in the observed period and that the general increase of market interest rates only had a minor impact on the LSTI ratio of borrowers who took out a consumer loan. On the other hand, the increase in market interest rates had a more pronounced impact on the synthetically calculated LSTI ratio of borrowers who took out a housing loan. This is due to the fact that the average interest rate for housing loans had almost doubled compared to the limited increase in the average interest rate for consumer loans. Also, the increase in the average housing loan amount contributed significantly to the increase in the synthetically calculated LSTI of borrowers who took out a housing loan.

The reduction of the average maturity of housing loan also had a non-negligible positive impact on the synthetically calculated LSTI ratio of borrowers who took out a housing loan. As with consumer loans, the general growth in the average income of borrowers limited the rise of the synthetically calculated LSTI of borrowers who took out a housing loan, but the increase in the average loan amount, the average interest rate and a reduction of the average maturity of the housing loans resulted in an overall increase of the synthetically calculated LSTI ratio of borrowers who took out a housing loan.

In Section 2, we present some stylized facts about the LSTI ratio, while in Section 3 we present the separate components of the LSTI calculation and their dynamics. In Section 4, we show how the LSTI ratio would evolve given different ceteris paribus assumptions, and in Section 5, we use the misalignment methodology in order to show the contributions of the main components of the LSTI share.

2 The loan service-to-income (LSTI) ratio

The loan service-to-income (LSTI) ratio measures how much of his income a borrower has to assign to repay his loan. It is a way of measuring the borrower's ability to service the loan. By limiting the borrower's maximum allowed LSTI ratio, the relevant policy makers can reduce the borrower's probability of a default (PD) and/or loss given default (LGD).

The monthly loan instalment i.e. the loan service amount, can be calculated using three variables. It is determined by the interest rate on the loan, the loan maturity and the loan amount. Below we present the equation for calculating the monthly loan instalment:[2]

$$P = \frac{(PV \times r)}{1 - (1+r)^{-n}} \tag{1}$$

[2] A financial function that calculates payment of a loan based on constant payments and a constant interest rate. The payment returned by the function includes principal and interest but not other fees sometimes associated with loans.

where:

- P ... monthly instalment,
- PV ... present value (loan amount),
- r ... periodic interest rate (annual interest rate divided by number of interest periods),
- n ... total number of interest periods.

Dividing the above equation with the borrower's income yields the LSTI ratio. From the equation above, we see that a higher periodic interest rate and a higher loan amount increase the monthly instalment, while a longer maturity of a loan lowers the loan instalment. Furthermore, the higher the borrower's income, the lower the LSTI ratio.

In this analysis, we investigate how the variables affecting the LSTI ratio have behaved over the past few years. Based on the loan-level data, we show how LSTI would evolve if other variables effecting the LSTI were held constant. We further evaluate the movement of synthetic LSTI according to changes in the above mentioned variables. With the results of our analysis, we better understand how these factors influence the development of LSTI ratio based on data from Slovenia and how individual factors can affect the LSTI ratio dynamics.

3 Data and stylised facts

The analysis is based on loan-level data from January 2020 to the end of 2023. Only loans with the French amortization system were taken into account.[3] Data is further separated between loans for consumption purposes and loans for house purchase.[4] First, we show

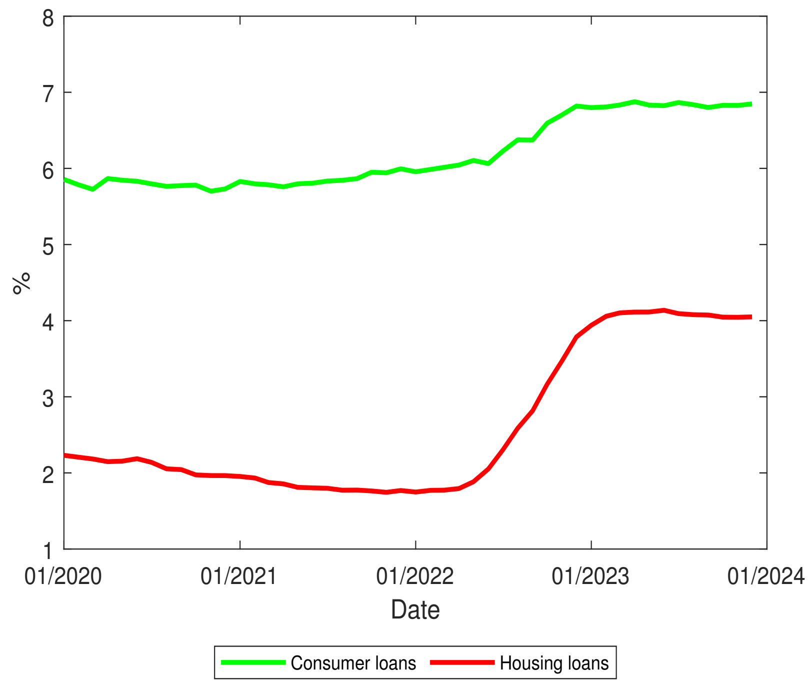
[3]Also known as the progressive (quota) method, it consists of paying back the same amount each month until the debt is fully settled. 99% of all loans were approved with the French amortization method.

[4]Loans for house purchase are all loans that are either secured by residential property or where the

the movement of the variables that affect the LSTI ratio in the time frame taken into analysis. Since we have loan-level data at our disposal, we first aggregate the data by month of loan origination and show the average value for that month.

Figure 1 shows the trend in the variable average interest rate of newly approved loans to households by type of loan. It can be seen that interest rates on newly approved housing loans have increased significantly compared to the increase in interest rates on consumer loans. While in 2023 the average interest rate for new consumer loans was about 18% higher than in 2020, it almost doubled for housing loans. Holding other variables affecting the LSTI ratio constant, we assume that an increase in the average interest rate of newly approved loans led to an increase in the LSTI ratio for both type of loans, with the increase being more pronounced for housing loans.

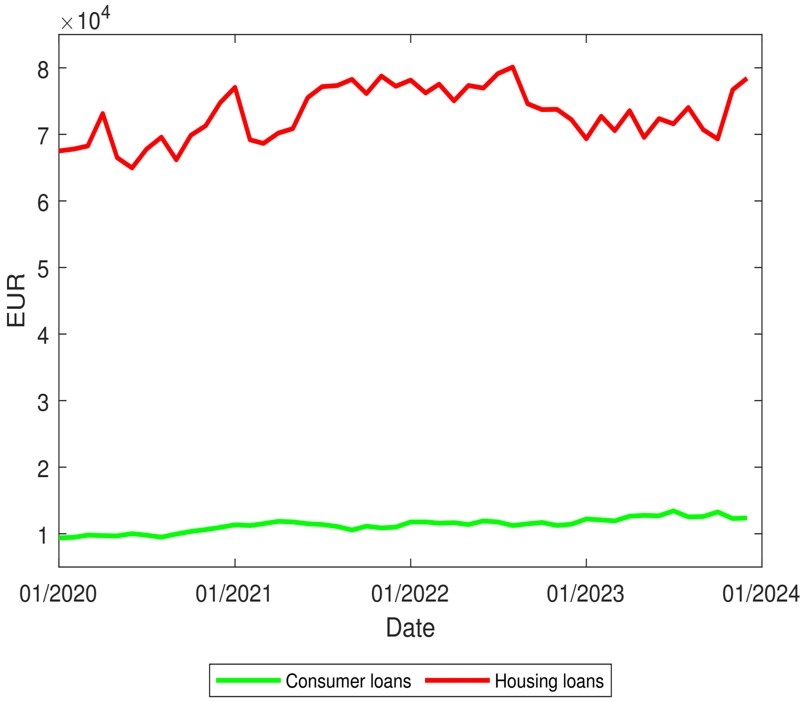
Figure 1: Interest rate on new loans by type of loan



Source: Banka Slovenije.

Next, we show the trend in the variable average loan amount of newly approved loans to households by type of loan. From Figure 2, we can see that the average loan amount has increased for both type of loans. However, the increase was more pronounced in consumer loans. From January 2020 to December 2023, the average loan amount increased by 32% for consumer loans and 16% for housing loans. Holding other variables affecting the LSTI ratio constant, we assume that an increase in the average loan amount of newly approved loans led to an increase in the LSTI ratio for both type of loans.

Figure 2: Average loan amount of new loans by type of loan



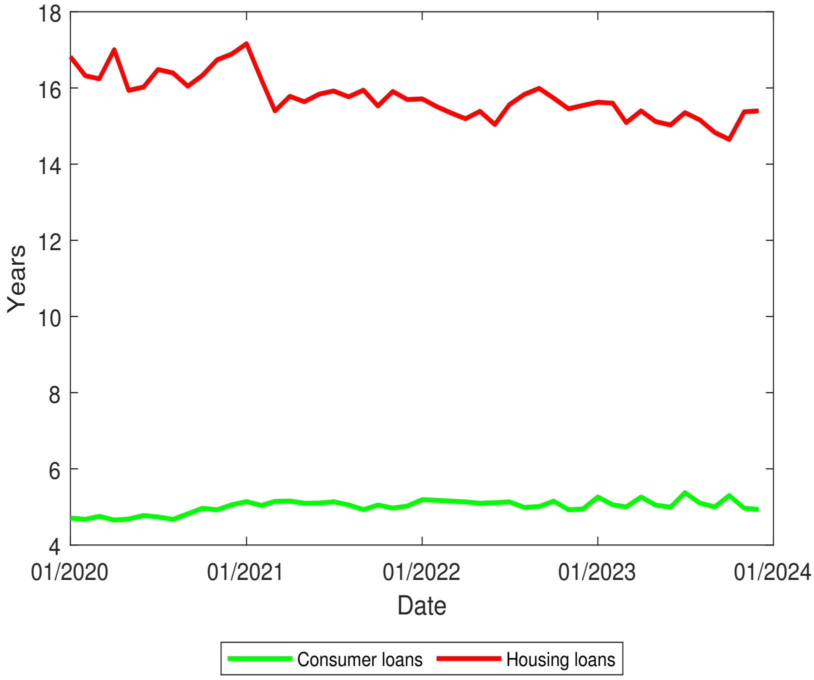
Source: Banka Slovenije.

Below we show the trend in the variable average loan maturity of newly approved loans to households by type of loan. Figure 3 shows that the average maturity of consumer loans was slightly longer in 2023 than in 2020, while it actually decreased for housing loans. Holding other variables affecting the LSTI ratio constant, we assume that an increase in the average maturity of consumer loans decreased the overall LSTI for consumer loans, while a decrease in the average maturity of housing loans increased the overall LSTI ratio

purpose of the loan was to acquire or maintain ownership of an existing or planned residential property (including renovation).

for housing loans.

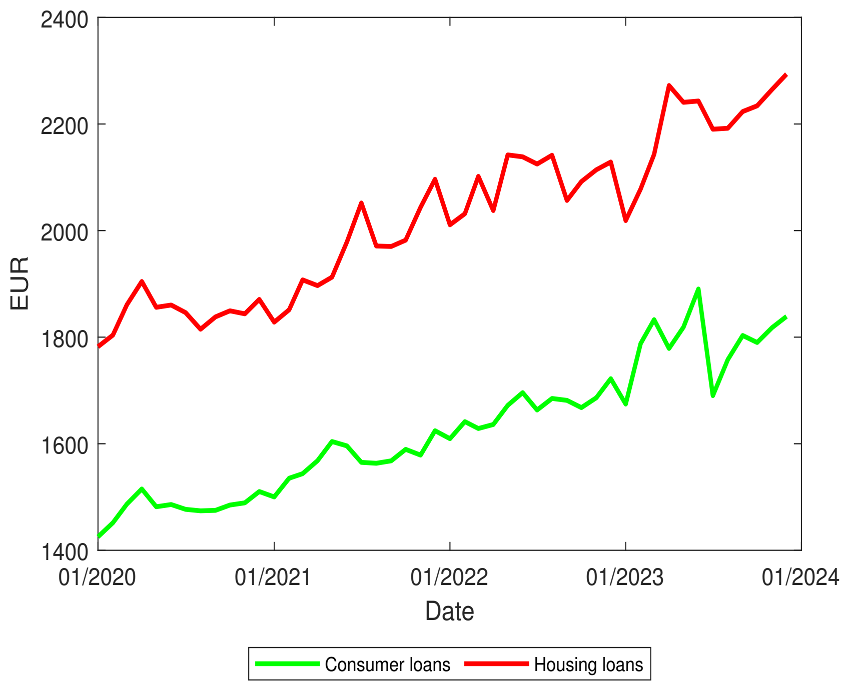
Figure 3: Average maturity of new loans loans by type of loan



Source: Banka Slovenije.

Finally, we show the movement of the denominator of the LSTI ratio, i.e. the average monthly income of borrowers. Figure 4 shows that borrowers who took out a housing loan had, on average, higher monthly incomes than borrowers who took out a consumer loan. In addition, we see that the average income of households that took out loans increased. We conclude that the growth of the average income of borrowers limited the increase in the LSTI ratio.

Figure 4: Average monthly income of borrowers by type of loan

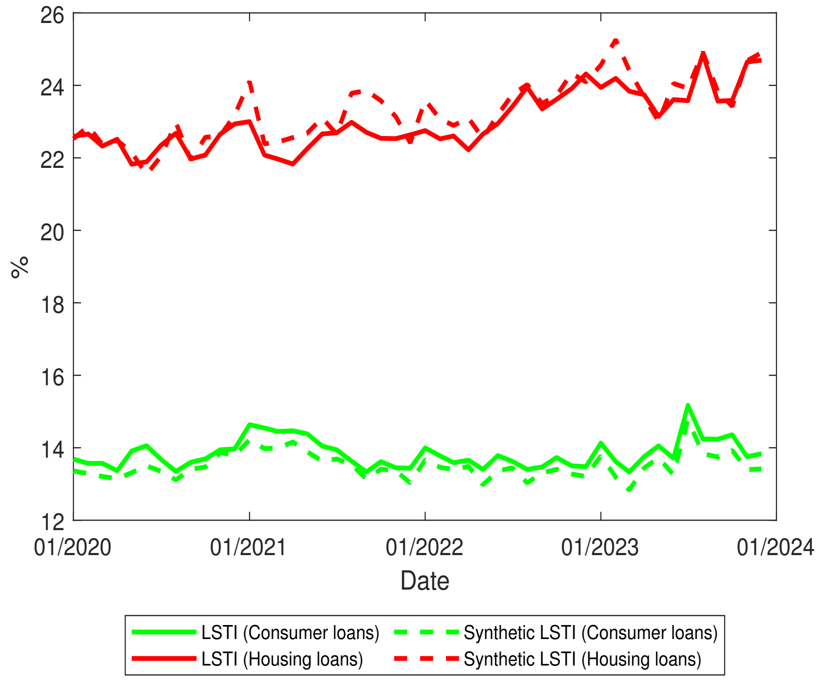


Source: Banka Slovenije.

Lastly, in Figure 5 we show the actual average LSTI ratio as reported by banks and synthetically calculated LSTI ratio based on average values of variables needed for its calculation.[5] We see that the average or the synthetically calculated LSTI ratio of borrowers who took out housing loans is much higher than that of borrowers who took out consumer loans. This is due to the fact that the loan amount for a housing loan was on average six times higher than that of consumer loans, which significantly increases the monthly instalment. We can also observe that the average or the synthetically calculated LSTI ratio of borrowers who took out consumer loans did not increase during the observed period, but it did increase for housing loans.

[5]The differences between average LSTI ratio and synthetically calculated LSTI ratio occur mainly due to the use of contractual interest rates in the calculation of synthetic LSTI ratio, while average LSTI ratio as reported by banks is based on effective interest rate, which includes the cost of credit approval and other fees.

Figure 5: Average LSTI by type of loan



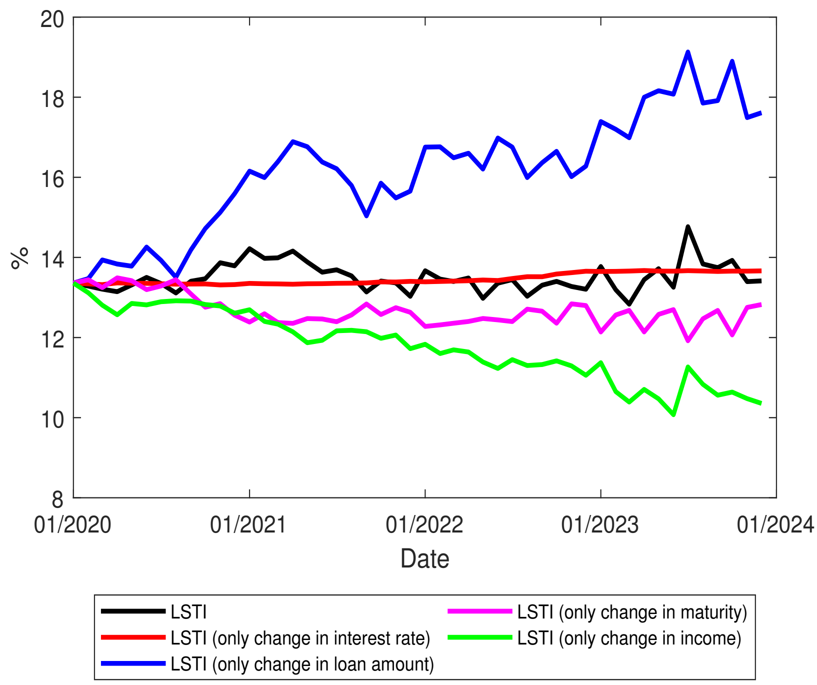
Source: Banka Slovenije, own calculations.

4 The LSTI ratio given different assumptions

In this section we investigate what would happen to the LSTI ratio if only one of the variables that affect LSTI was to change while other variables were to remain unchanged. The idea here is to highlight and show how a change in a single variable would affect the dynamics of the synthetically calculated LSTI ratio.

In Figure 6 we show the dynamics of the synthetically calculated LSTI ratio of borrowers who took out a consumer loan if only one variable affecting the LSTI ratio changed while the others remained unchanged, thus applying the ceteris paribus condition. We can see that the increase in the average loan amount has the strongest positive effect on the synthetically calculated LSTI ratio of borrowers who took out a consumer loan. The increase in the average income of the borrower who took out a consumer loan decreases the synthetically calculated LSTI ratio. Other factors affecting the LSTI ratio had a smaller effect on the synthetically calculated LSTI ratio. In fact, the increase in interest rates had the smallest impact on the synthetically calculated LSTI ratio. We can conclude that the factors affecting the LSTI ratio of borrowers who took out a consumer loan more or less levelled out in the observed period and that the general increase in interest rates had only a minor impact on the LSTI ratio of borrowers who took out a consumer loan.

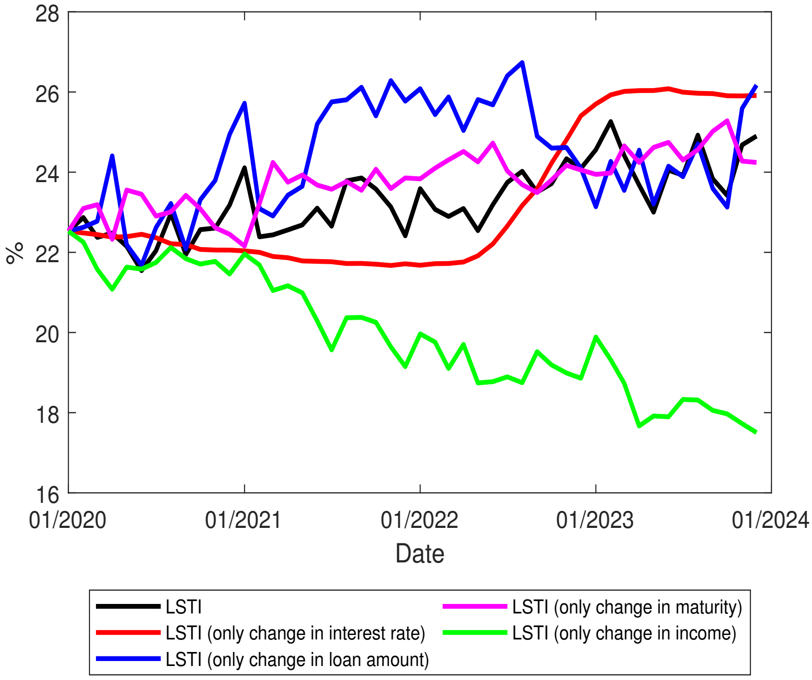
Figure 6: Synthecially calculated LSTI ratio of borrowers who took out consumer loans



Source: Banka Slovenije, own calculations.

In Figure 7 show the dynamics of the synthetically calculated LSTI ratio of borrowers who took out a housing loan, if only one variable affecting the LSTI ratio changed, while the others remained unchanged. We can see that the increase in the average loan amount and the increase in the average interest rate had the strongest positive effect on synthetically calculated LSTI ratio of borrowers who took out a housing loan. The reduction of the average maturity of housing loan also had a non-negligible positive impact on the synthetically calculated LSTI ratio. Similar to borrowers who took out consumer loan, among borrowers who took out a housing loan, the growth of general income inhibited the increase of the LSTI ratio, but the growth of the aver-age loan amount, the average interest rate and a reduction of the average maturity of the housing loans resulted in an increase in the overall LSTI ratio of borrowers who took out housing loan.

Figure 7: Synthetically calculated LSTI ratio of borrowers who took out housing loans



Source: Banka Slovenije, own calculations.

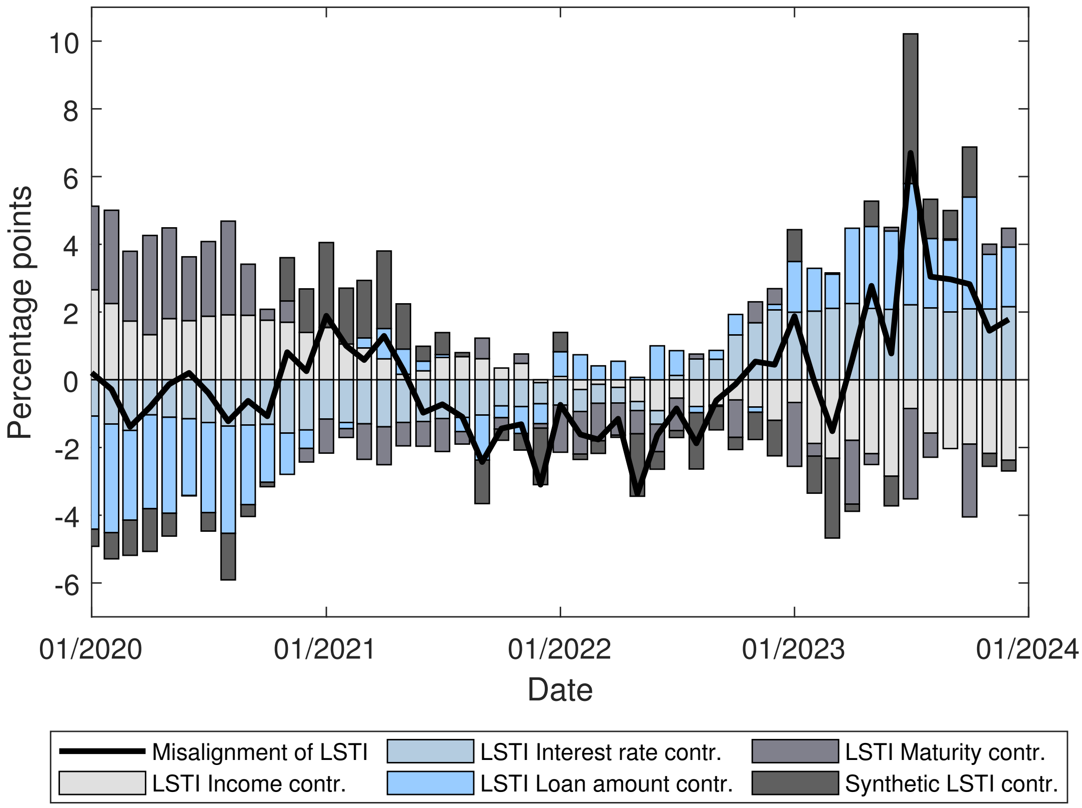
Next we show how factors affecting the LSTI ratio affected the LSTI ratio each month of the observed period and in which way were they driving the LSTI ratio. We do this by utilizing the misalignment indicator methodology, which was seminally applied by Schneider (2013).

5 Misalignment factors of the LSTI ratio

We simulate contributions of the separate sub-factors that were explained above and are the main drivers of the LSTI dynamics. We did this by utilizing the misalignment indicator methodology, which was seminally applied by Schneider (2013). In short, with the misalignment methodology, we first determine weighting factors of sub-factors by applying a PCA methodology with which the cyclical co-movement of the separate sub-factors is emphasized. In the second step, the aggregate misalignment indicator can be derived by weighting the sum of all sub-factors.

Figure 8 shows the contributions of the main factors to the LSTI deviation for consumer loans. The figure shows the positive contribution of the interest rate of consumer loans to the LSTI ratio when the interest rates started to increase, i.e. in the second half of 2022. Before that period, decreasing interest rates had a deductive effect on the average LSTI ratio. The increase in the average loan amount also contributed positively to the rise of the LSTI ratio in 2023. In July 2023, Banka Slovenije changed the methodology for calculating consumers' creditworthiness. This amendment allowed consumers to take out a larger loan amount based on their income. On the other hand, the effect of the average maturity was rather subdued. What is also noteworthy to the analysis is that the income effect had a negative contribution to the LSTI ratio dynamics only in the second half of the observed period. This is due to a sizeable increase in average wages of consumers in 2023.

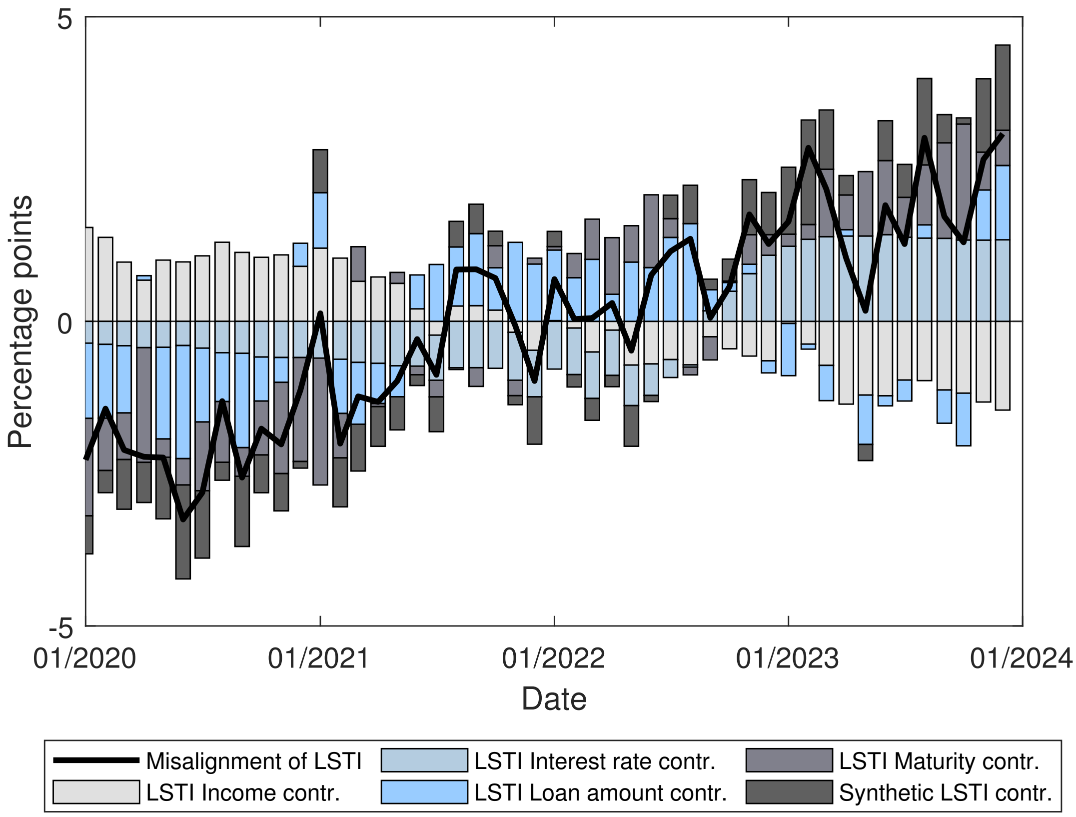
Figure 8: Contributions of factors driving the LSTI deviation for consumer loans



Source: Banka Slovenije, own calculations.

Further, Figure 9 shows the contributions of the main factors to the LSTI deviation for housing loans. Similarly to the case of consumer loans, the synthetic LSTI ratio is in-creasing due to the increase in the interest rates on housing loans. Contrary to the in-crease of the loan amount in consumer loans, the loan amount contribution effect of the housing loans has stayed rather subdued in the last year or so. On the other hand, the decrease in the average maturity of housing loans increased the average LSTI ratio. As with consumer loans, the income effect had a negative contribution to the LSTI ratio dynamic.

Figure 9: Contributions of factors driving the LSTI deviation for housing loans



Source: Banka Slovenije, own calculations.

To sum up, the results show that the increase in the average loan amount had the strongest positive effect on the synthetically calculated LSTI ratio of borrowers who took out a consumer loan, ceteris paribus. Other factors affecting the LSTI had a smaller effect on the synthetically calculated LSTI ratio of borrowers who took out a consumer loan. In fact, the increase in the average interest rate for consumer loans had the smallest impact on the synthetically calculated LSTI ratio of borrowers who took out a consumer loan. While the rise in market interest rates had a positive effect on the LSTI ratio of borrowers who took out a consumer loan mainly in the second half of 2022, the effect was not pronounced, due to the limited rise of the average interest rate of consumer loans. The increase in the average maturity of consumer loans had a negative impact on the LSTI of borrowers who took out consumer loan; however, due to the maturity limits set by the macroprudential regulation, the extension of the loan maturity to reduce monthly instalment and thus the LSTI ratio is limited. The increase in the average income of the borrowers who took out a consumer loan, however, offset the increase of the synthetically calculated LSTI ratio. We conclude that the factors affecting the LSTI ratio of borrowers who took out a consumer loan more or less levelled off in the observed period and that the general increase of market interest rates only had a minor impact on the LSTI ratio of borrowers who took out a consumer loan. On the other hand, the rise in market interest rates had a more pronounced impact on the synthetically calculated LSTI ratio of borrowers who took out a housing loan. This is due to the fact that the average interest rate for housing loans had almost doubled compared to the limited increase in the average interest rate for consumer loans. Also, the increase in the average housing loan amount contributed significantly to the increase in the synthetically calculated LSTI of borrowers who took out a housing loan. The reduction of the average maturity of housing loans also had a non-negligible positive impact on the synthetically calculated LSTI ratio of borrowers who took out a housing loan. As with consumer loans, the general growth in the average income of borrowers limited the rise of the synthetically calculated LSTI of borrowers who took out a housing loan, but the increase in the average loan amount, the average interest rate and a reduction of the average maturity of the housing loans resulted in an overall increase of the synthetically calculated LSTI ratio of borrowers who took out a housing loan.

6 Conclusions

In this analysis, we introduce a synthetically calculated LSTI and evaluate the dynamics of the synthetically calculated LSTI given different assumptions of factors affect-ing the LSTI. We simulate contributions of the individual sub-factors, i.e. borrowers' income, interest rate of loans, loan maturity and loan amount, for which we know that are the main drivers of the LSTI dynamics. We did this using the misalignment indicator methodology seminally applied by Schneider (2013) and other studies.

The results of the analysis reveal that the increase in the average loan amount significantly boosted the LSTI ratio for consumer loan borrowers, while other factors had a lesser impact. Specifically, the rise in average market interest rates for consumer loans had the smallest effect. Although market interest rates positively influenced the LSTI ratio in the latter half of 2022, this effect was muted due to a limited rise in consumer loan rates. Additionally, while longer loan maturities negatively affected the LSTI, the macroprudential regulation restricts their extension. To the contrary, higher borrowers' income helped offset the LSTI ratio increase. Overall, factors influencing the LSTI for consumer loans somewhat balanced out, with market interest rates having minimal effect. With respect to the mortgages, rising market interest rates significantly impacted the LSTI ratio for housing loan borrowers, as their average interest rates nearly doubled. The increase in housing loan amounts and a reduction in loan maturities further elevated the LSTI ratio, although higher borrower incomes continued to moderate this rise.

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