ADVISORY PANEL ON CONSUMER PRICES - TECHNICAL

Lenders' formula method for mortgage interest repayments

Status: Work in progress Expected publication: For publication alongside minutes

Purpose

1. This paper reviews the mortgage interest payments methodology in the Household Costs Indices (HCIs), following feedback from the Stakeholder Panel, and complements the parallel paper (*APCP-T(21)08 Current mortgage interest payments methodology: a review*) reviewing the current methodology.

Action

- 2. Members of the Panel are invited to:
 - a) comment on the lenders' formula method for the computation of a mortgage interest payment index;
 - b) comment on the data sources used;
 - c) comment on including fixed interest rates for the 90% and 95% LTV ratios;
 - d) comment on the differences between the index from the RPI and the index from the new method.

Background

- 3. Household Cost Indices (HCIs) aim to reflect UK households' experience of changing prices and costs. They are intended to measure how much the nominal disposable income of different household groups would need to change, in response to changes in prices and costs, to enable household groups to purchase the same quantities of goods and services at a fixed quality. The broad approach of the HCIs is thus to measure the outgoings of households.
- 4. The HCIs are in development, and we are producing annual publications of monthly estimates back to 2005 (see <u>Third preliminary estimates</u>, 2005 to 2019). The focus is on inflation for different subgroups of the population, although we make the necessary assumption that different groups face the same prices and that spending patterns drive the differences between groups.
- In the most recent publication (<u>Third preliminary estimates, 2005 to 2019</u>), the HCIs differed from our other inflation measures in the use of democratic weighting, of a payment approach (for OOH, tuition fees/loans and insurance) and of financial debt payments.
- Following feedback from the Stakeholder, we are reviewing the method for calculating mortgage interest payments for the next publication, due at the end of 2021. Roadmap of our development plans for HCIs is available <u>here</u>.
- 7. There are a number of streams to this work. The parallel paper *APCP-T(21)08 Current mortgage interest payments methodology: a review* provides a sensitivity analysis of the current parameters used in the calculation of mortgage interest under the Retail Prices Index (RPI) method. Future work will involve calculating mortgage interest under the simple

revaluation approach (currently used by Stats Can and Stats New Zealand, and referenced in the <u>latest methodological paper</u>. In this paper we consider the development of an alternative approach to measuring the change in mortgage interest payments.

- 8. Because of the need to reflect budget pressures faced by households in the HCIs, some elements of the HCIs basket reflect items for which there is no well-defined 'price'. This is true of the interest components in the HCIs. Interest payments are the amount paid to borrow money, or for delaying the repayment of a debt, with costs increasing when interest rates rise, and the size of repayments dependent on the size of the initial debt that is being repaid¹. They are not part of CPIH, which measures the changing cost of consumption goods and services. Interest payments are however measured by the HCIs which treat interest payments as a household outgoing, therefore both financial debt and mortgage debt are part of the HCIs. The computation of an index for interest payments is complicated by the fact that interest is the cost of borrowing and therefore there is no price associated with financial debt or mortgage debt. For financial debt we use a revaluation approach, for mortgage debt we can use a 'quasi-price' index, which will be described later in the paper.
- 9. Mortgage interest payments (MIPs), as computed for the aim of the RPI, are part of the HCIs through their inclusion in OOH costs, which is measured on a payments basis. This paper presents a computational method which is based on the <u>financial formula</u> that is used by lenders for the calculation of mortgage repayments.
- 10. For the application of the lenders formula, the data sources consisted of BoE mortgage interest rates and of the average price advanced from ONS HPI publications. The data sources will be described in detail later in the paper.
- 11. Alongside including MIPs in the HCIs, discussion has focussed on the appropriateness of also adjusting for capital mortgage repayments which are not part of consumer price inflation measures as they represent the purchase of assets. In July 2019, the National Statistician decided that the ONS will develop a measure of capital mortgage repayments "in a variant measure, the HCIC (HCI Capital), after work on the main HCIs has been completed. This will allow users with varying needs to select the best measure for their purpose". In reference to developing a capital variant measure, the Annex shows the index of capital mortgage repayments which is obtained under the financial formula deployed for interest mortgage repayments and described in this paper.

Introduction

12. Average interest payments at any point in time depend on the existing mortgages and on the mortgages that started at the beginning of the current period. For example, assuming all mortgages have a lifespan of 25 years, interest payments in April 2021 result from all repayments between March 1996 and April 2021².

¹ Households also face offsetting gains when interest rates rise, e.g. through savings, which is however out of scope of the HCIs as currently defined. This was discussed in Martin Weale's paper on the HCIs (APCP-T(20)14, publication forthcoming), presented at the <u>APCP meeting in October 2020</u>.

² Although the lifespan is not fully comparable with the RPI which uses 23 years, the index based on the new method is not affected as explained in the Strengths and Limitations Section.

- 13. Over the duration of a mortgage, interest payments are larger over the first half of the loan, to decline later as capital repayments gradually increase. Therefore, to capture interest payments optimally for the aim of a mortgage interest payment index, it is important to design a method which accounts for payments from a range of mortgage cohorts, with a contribution proportional to the remaining lifespan of the mortgage.
- 14. Whilst there is no 'price' associated with mortgage interest, and the mortgage interest index is properly an index of costs or repayments, the HCIs belong to the wider family of price indices. A price index usually has a 'price' element, which varies over time, and a 'quantity' or 'expenditure' element, which is fixed so that the index measures pure price change but also accounts for the economic importance of an item. We therefore also consider how the lenders' formula (described in the following section) can be adapted to reflect the key properties of a price index.
- 15. We can create a quasi- 'price' for mortgage interest by applying the interest rate to a stock of debt to derive a mortgage interest payment. But the level of debt is not fixed over time: the average level of debt changes from month to month, as does the monetary value of that stock of debt. We therefore also consider how the debt can be 'fixed' in this methodology.
- 16. The next two sections describe the formula that is used by mortgage lenders to derive monthly (capital and interest) repayments. We then present the data sources that we used in order to apply the formula, and finally we describe how the formula has been adapted to allow the creation of a mortgage repayment index.

Financial formula for mortgage repayments

- 17. When a candidate mortgagor applies for a mortgage, the lenders derive mortgage repayments based on the amount of the loan, the length of the mortgage and the type of interest rate (fixed or variable) which can vary depending on the loan-to-value (LTV) ratio.
- 18. In particular, lenders use the following financial formula which, by design, provides the exact payment at each point in time that will enable the full debt to be paid off by the end of the mortgage:

$$T = \frac{Loan * R^n}{(R^n - 1)} (R - 1)$$

Equation 1

Where

T is the total monthly repayment

$$R = \left(1 + \text{interest rate} * \frac{1}{12}\right)$$

n is the mortgage length in months (e.g. 300 for a 25-year mortgage)

19. If the mortgage rate was fixed over the full duration of the mortgage, the monthly mortgage repayments would only be computed at the start of the loan. In the absence of interest rates

of such length, Equation 1 is rerun at the end of each interest rate period to provide the new monthly payment. It follows that the equation is rerun every month for a variable rate and every k years for a k-year fixed interest rate.

20. While for the first repayment the 'balance' consists of the loan itself, subsequently it consists of the remaining debt after adjusting for payments to date. The following equations illustrate the computation of the monthly payment and of the balance after the first time period.

$$T = \frac{Balance * R^n}{(R^n - 1)} (R - 1)$$

Equation 2

 $Balance_2 = Loan - Principal_1$ $Principal_1 = Loan - Total payment_1$

- 21. To note, the 'Principal' is the capital payment.
- 22. The equation for the balance can be generalised as follows for any month over the duration of a mortgage:

 $Balance_{i+1} = Balance_i - Principal_i$ i = 1, ..., n Equation 3

n = length of mortgage in months

Principal_i = Payment_i - Interest portion_i

23. The monthly interest portion is given by:

 $I = Loan \frac{rate}{12}$ for first time period

 $I = Balance \frac{rate}{12}$ for subsequent periods

24. For the sake of simplicity, equation 1 and 2 are simplified as follows:

$$K = \frac{R^{n}}{(R^{n} - 1)} (R - 1)$$

$$T = \text{Loan} * K$$

$$Equation 1.1$$

$$T = \text{Balance} * K$$

$$Equation 2.1$$

Financial formula for mortgage repayments: Example

25. As an example, let us consider the computation of a monthly repayment alongside its interest portion for a mortgage which began in January 1995, with a loan of £105,000 to be paid off over a 25-year mortgage. If the mortgage is at a 5-year fixed rate, the monthly payment from January 1995 to December 1999 is £626.12, with an interest portion of £455 in the first month.

5-year fixed interest rate = 0.052

K =0.005963015

 $Total = 105,000 * K = \pounds626.12$

Interest = $105,000 \frac{0.052}{12} = \pounds 455.00$ for first time period

26. After the first payment, the balance decreases by an amount equal to the initial debt minus the principal. The up-to-date balance is thus used for the computation of the interest portion in subsequent months after the first payment. For example, in the second month of the mortgage, the monthly payment is still £626.12, with an interest portion of £454, as the equations below show.

 $Balance_2 = \pounds 105,000 - (\pounds 626.12 - \pounds 455) = \pounds 104,828.88$

 $Interest_2 = 104,828.88 \frac{0.052}{12} = \pounds454.00$

- 27. The monthly computation of the balance and of the interest portion continues then invariably until December 2009, when the 5-year rate fixed period ends.
- 28. In January 2010, the mortgage repayment is recalculated (Equation 2.1) using the new interest rate which is then reflected in the computation of the balance for the principal part of it. The computation of the balance and of the interest part is then repeated monthly, keeping constant the total monthly payments, up to the end of the new five-year term. The structure of the calculations is then updated every five years, until the end of the mortgage lifespan.
- 29. If the interest rate is a 2-year fixed rate, the above formulation (for a 5-year fixed rate) is adjusted to reflect changes in the total monthly payments every two years. For a variable rate, the formulation is accordingly adjusted to reflect changes on a monthly basis.

Lenders' formula: UK Data

30. The application of the lenders' formula requires three types of data:

- Interest rate
- Mortgage lifespan
- Price advanced (i.e. amount of mortgage)
- 31. Mortgage interest rates are published by the Bank of England (see Table 1A in Annex for a full list of the mortgage rates series published by the BoE). To best approximate true interest payments, we accounted for both variable and fixed rates.
- 32. As a variable rate, we used the revert-to-rate series (IUMTLMV) which exists continuously since January 1995 and can be considered as the standard variable rate.
- 33. Fixed rates vary depending on the loan-to-value (LTV) ratio, with rates increasing with the LTV ratio to offset the risk of insolvency. The selection of fixed rates for the analysis was based on two criteria: representativeness of the LTV ratio across all the mortgages and length of the fixed rates series. Based on the higher completeness of fixed interest rates for a 75% LTV and the fact that more than half of mortgages have such an LTV ratio (FCA Mortgage Lending Statistics), the 75% LTV was selected for the application of fixed interest rates. In particular, the following two series were used:
 - Monthly interest rate of UK monetary institutions (exl. Central Bank) sterling 2 year (75% LTV) fixed rate mortgage to households (in percent) not seasonally adjusted (IUMBV34), from January 1995
 - Monthly interest rate of UK monetary institutions (exl. Central Bank) sterling 5 year (75% LTV) fixed rate mortgage to households (in percent) not seasonally adjusted (IUMBV42), from January 1995
- 34. Figure 1 shows the mortgage interest rates used for the application of the lenders' formula.



Figure 1: Mortgage interest rates used for the application of the lenders formula for first time buyers

Source: BoE

- 35. To date, no publications are available on the lifespan of a mortgage, either in a calendar year or for mortgage cohorts. In the absence of a publication, we assumed a 25-year mortgage lifespan which is comparable to the RPI which uses a 23-year length.
- 36. It should be noted that, for the lender formula method, the length of the mortgage has no impact on the mortgage interest payment index, provided the same length is applied uniformly across the mortgage cohorts. This is because any change in the interest payments will only result in a proportional effect, leading to the same ratios involved in the construction of a price index independently of the selected constant lifespan.
- 37. The price advanced for first time buyers, former owner occupiers and all dwellings is part of the <u>UK House Price Index publications</u>, with information available since quarter 1 in 1992. ONS inherited the <u>publication</u> from the Ministry of Housing, Community and Local Government, formerly DCLG (Department for Communities and Local Government). From 2005, the average advance is based on the <u>UK Finance Regulated Mortgage Survey</u> with a coverage of about 70 per cent of all mortgages regulated by the Financial Conduct Authority.
- 38. As an initial application of the lenders' formula, we only used the average advance for first time buyers (Figure 2). The data were extracted from the ONS HPI publications from 1995 onwards, in line with BoE rates being available from 1995.



Figure 2: Average price advanced for first time buyers. Quarter 1, 1995 to 2020

Source: ONS HPI, formerly published by DCLG

Lenders' formula: Method for the computation of a mortgage repayment index

- 39. A price index is constructed by pricing identical products from period to period. In the absence of prices, a 'quasi-price' or 'cost' index can be used. This is the HCIs approach for the computation of the student loan repayment index, since there is no price associated with a repayment. As prices of mortgage interests do not exist, a similar approach can be adopted for a mortgage interest repayment index.
- 40. We can create a 'quasi-price' for mortgage interest by applying the interest rate to a debt (i.e. the price advanced or loan), and use the resulting input to derive a mortgage interest

payment. However, since both prices advanced and interest rates change through time, to allow for direct 'costs' comparisons to be made, prices advanced have to be kept constant over a calendar year so that the 'costs' are only related to the varying interest rate. For the analysis presented here, the price advanced was fixed at quarter 1 over the rest of the calendar year.

- 41. As mentioned above, the mortgage lifespan was defined to be 25 years. While the computation for a mortgage variable rate simply entailed re-running Equation 2.1 every month over a 25-year period, for mortgage fixed rates some assumptions were required.
- 42. The first assumption was about the type of rate over the duration of the mortgage. This is because at the end of a fixed rate period, the option for a mortgagor is either a new fixed rate period, of similar or different length than previously, or a variable rate. There are however no data available on the product selected through time over the duration of a mortgage. For the sake of simplicity, it was assumed that at the end of the first time period the terms were constantly renewed for an interest rate of similar type and length up to the 25th year (e.g. 2-year fixed rate mortgages were renewed every two years), with the new rate extracted from the corresponding BoE series.
- 43. For fixed rate mortgages, an assumption about the date of the initial mortgage terms was required in order to establish the starting rate. When a fixed-rate mortgage is issued, the interest rate refers to the time of the application, with terms remaining valid for six months. It was assumed that the mortgage was issued at the time of the exchange of contracts, generally a month before the completion of the purchase when the repayments begin. For instance, a 2-year fixed rate mortgage cohort started in April 1998 at the March quoted rate.
- 44. To account for interest variability for each type of rate (i.e. fixed vs variable), the analysis presented here was repeated four times a year. To note, a monthly analysis would best capture interest variability, especially at times of changes in rates over a year.
- 45. Under the above specifications, the method spanned from 1995 to 2020 and involved the following steps.
 - Fix the price advanced within a calendar year
 - From 1995, create a series of interest repayments for each type of interest, that is for a 5year fixed, 2-year fixed and variable rates
 - Repeat step (2) four times a year (January, April, July, October)
 - Run each mortgage series up to 300 months (i.e. 25 years).
 - Obtain a summary value of interest payments for each mortgage cohort as a weighted average of the fixed and variable rate products in the mortgagor population for that specific cohort. (Please note that for this paper a simple average was used)
 - Average out all mortgage cohorts contributing to interest payments from January 2005 onwards
 - Derive mortgage interest repayment index from January 2005 onwards as the change in average repayments
- 46. Figure 3 indicates how average interest payments in June 2010 were derived from the cohorts whose mortgage repayments started between January 1995 and April 2010. A computational example is provided in ANNEX B in the accompanying excel file, where the mortgage cohorts

starting in January, April, July and October are followed for 24 months and average payments across the cohorts are derived for the computation of an index.





average of 59 cohorts: £280.92

Mortgage Interest Payment Index (Average 2015=100)

Lenders' formula method

- 47. Consistently with the RPI, the index presented here is called 'mortgage interest payment' (MIP) index. The MIP index based on the lenders formula was obtained from January 2005 to December 2020 and is shown in Figure 4, which also plots the three interest rates for the aim of enhancing data interpretation.
- 48. From January 2009, we notice a downward trend for the MIP index and for the two series of fixed rates, whereas the variable rate was stably in the range of 4 to 5 per cent (Figure 4). The MIP index appears thus to reflect the fixed rates, which is in line with the larger weight of fixed mortgages, about 67 per cent across all the mortgage cohorts in the analysis.



Figure 4. MIP index, variable rate and 75% LTV fixed rates. January 2005 to December 2020

Source: own analysis; BoE

Coverage of LTV ratios

- 49. The use of average prices advanced for first time buyers only and of a selection of mortgage rates may raise questions as to whether the MIP index in Figure 4 departs from the 'true' index.
- 50. To address the query as to whether the index would be different for former owner occupiers, we can look into how the method works. In the lenders' formula method, three types of mortgage rates were applied to the same average advance in a calendar year, three mortgage cohorts were then followed up until all the debt was paid off and an average mortgage cohort was obtained as a summary. Although a higher average advance implies higher interest rates compared to first time buyers, a constant shift through the series will result in a similar index as for first time buyers. Therefore, the derived index for first time buyers is expected to provide a good reflection of the true index.
- 51. The query about the limited range of mortgage rates can be addressed by verifying whether unaccounted LTV ratios have significantly different mortgage rates than those adjusted for in the analysis.
- 52. Comparisons were run between the 75% LTV (in the analysis), the 90 % LTV and the 95% LTV whose products have a shorter time series (see Table 1A in the Annex). Figure 5 shows the 2-year fixed rate for the 75% and 90% LTV ratios, whereas Figures 6-7 extend the comparison to a 95% LTV ratio for a 2- and a 5-year fixed rate.

53. With differences up to two percentage points, the comparison points to expanding the method to also include fixed rates for a 90% and a 95% LTV ratio. The adjustment for the 90% LTV ratio is deemed to be more relevant, being more frequent than the 95% ratio.



Figure 5: 2-years fixed rates for the 75% LTV and 90% LTV ratios. June 2009 to December 2020

Source: BoE

Figure 6: 5-years fixed rates for the 75% LTV and 95% LTV ratios. January 1995 to September 2008; November 2013 – December 2020



Figure 7: 2-years fixed rates for the 75% LTV and 95% LTV ratios. December 1995 to April 2008; October 2013 – December 2020



75% and 95% LTV ratio: 2-year fixed rate mortgage

Source; BoE

Comparison with RPI

- 54. The lenders formula method provides an alternative mortgage interest payment index to the index which is currently estimated in the RPI and is included in the owner-occupiers housing (OOH) costs class for CPIH(payments) and the HCIs.
- 55. In the RPI, from 2005 to 2009, the measure of MIPs was based on the standard variable rate. Following a review, the rate was replaced in 2010 by the average effective rate which covers around 90 per cent of bank and building society mortgage lending.
- 56. For the lenders formula, it was decided to use the specific rates for certain products. This is because the formula consists of simulating mortgage payments under the same criteria faced by mortgagors. When the mortgage rate is fixed, the rate is constant for the duration of the rate period. If an average rate, rather than the specific rate for the selected product, is used, the payments will be over or underestimated depending on the direction of the average rate with respect to the actual fixed rate.
- 57. Figure 8 shows the MIPs from the RPI and the lenders' formula. The indices overlap between January 2007 and January 2009, reasonably as a result of similarly high mortgage rates over the economic crisis. From January 2009 the MIP in the RPI has a more flat trend which mirrors the adopted interest rate (Figure 9), although other factors might also play a role in the RPI index which adopts a complex methodology.

58. In terms of annual growth rate, the impact of the economic crisis is more apparent in the RPI than in the lenders formula method because the adjustment for fixed-rate mortgages reduces the impact of swift changes in the interest rate (Figure 10).



Figure 8: MIP index from RPI and from lenders' formula method. January 2005 to December 2020

Source: own analysis; RPI



Figure 9: RPI: MIP index and mortgage interest rate. January 2005 to December 2020



Figure 10: MIP index from RPI and from lenders' formula method. Annual growth rate. January 2006 to December 2020

Source: own analysis; RPI

Strengths and limitations

- 59. The strength of the method lies in the application of the exact formula used by lenders, so capturing the payments received by banks holding the defining criteria (price advanced, type of interest, mortgage lifespan). It can be reasonably argued that the more far is an estimation method from the actual method, the larger is the risk of bias.
- 60. Another advantage refers to the data sources required, consisting of interest rates and average advance only.
- 61. In the method presented here, the index is independent of any mortgage lifespan, provided the same lifespan is applied uniformly across all mortgage cohorts. For example, if a 20-year, rather than a 25-year, mortgage had been applied to each cohort, the index would have been the same because payments maintain a proportionality factor under a different lifespan. If, however, owing to changes to mortgage lifespans, it is reasoned that the current assumption of a constant lifespan produces payments significantly different from expected, an alternative approach should be adopted, with lifespans varying by mortgage cohorts and estimated from surveys.
- 62. As the lenders' formula entails the computation of capital payments (see Equation 3), the method could be taken into consideration for the development of the planned HCIC's capital variant measure.
- 63. There are certain limitations to the method which warrant discussion. Firstly, the weights associated with fixed and variable rates are available from 2007, implying that before this date

the differential contribution of fixed and variable rates is not accounted for, leading to a potential overestimation of fixed rates. Secondly, the method is based on the most common type of fixed rates for which the BoE publishes the series, whereas less frequent interest rates are not available. This limitation is however diminished by the fact that, being typical, the available series of interest rates account for most mortgages. Thirdly, the average advance may be biased between 1995 and 2004 when it was based on a small sample. From 2005 the estimate of the average advance, which ONS inherited from DCLG, is based on the Regulated Mortgage Survey, with a 70 per cent coverage of all the mortgages regulated by the Financial Conduct Authority. Options are currently investigated for more representative average advance data before 2005, such as using LTV median on house prices, verifying whether external stakeholders could provide data and using backward questions from the Wealth and Asset Surveys.

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Prices Division, ONS April 2021

List of Annexes

Annex A	Capital mortgage repayments
Annex B	Worked example of the MIPs lenders formula method

Annex A – Capital mortgage repayments

Figure 1A: Interest, capital and total mortgage repayments indices. Lenders' formula method, variable rate and 75% LTV ratio fixed rates. January 2005 to December 2020



Month

Source: own analysis

	60% LTV ratio		75% LTV ratio		85% LTV ratio		90% LTV ratio		95% LTV ratio		Independent of LTV ratio	
	Code	Series	Code	Series	Code	Series	Code	Series	Code	Series	Code	Series
2-year fixed	IUMZICQ	Jan2012+	IUMBV34	Jan1995+	IUMZICR	Jan2012+	IUMB482	May2008- Feb09;	IUM2WTL	Dec1995- Apr2008; Oct2013+		
3-year fixed			IUMBV37	Jan1995+				Juneos	IUM3WTL	Jan1998+		
5-year fixed	IUMZO27	Feb2019+	IUMBV42	Jan1995+			IUMZO28	Feb2019+	IUM5WTL	Jan1995- Sept2008; Nov2013		
10-year fixed			IUMBV45	Jan1995- Aug2009; Aug2014+					IUMB9N8	Jan1995- Dec07		
2-year variable rate			IUMBV48	April1998+			IUMB479	Short series, March2008	UM2WDT	April1998- March2008; Feb2019+		
Standard variable rate											CFMBX2D	Jan2011+
Standard variable rate											IUMBKMV	Jan1995- Oct03
Revert-to-rate mortgage											IUMTLMV	Jan1995+
2-year fixed											CFMBX2F	Jan2011+
3-year fixed 5-year fixed											CFMBX2G CFMBX2H	Jan2011+ Jan2011

Table 1A. Mortgage interest rate series. BoE