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Зарубежный опыт

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ХАРАКТЕРИСТИКА ИПОТЕЧНЫХ КРЕДИТОВ И НОВОЕ РЕШЕНИЕ

В связи с ростом численности населения в мире и повышением уровня жизни возникает естественная необходимость действенного решения жилищных проблем. Авторами статьи предлагается новая формула для использования на ипотечном рынке, которая основывается на концепции «непрерывности приведенной стоимости погашений». Данное решение обеспечивает заемщику более низкие, в пересчете на текущую стоимость, первоначальные ежемесячные платежи. Новый подход предлагает альтернативу такому методу, как сдача в аренду собственности, и может послужить практическим инструментом, помогающим всем желающим стать собственниками жилья, что в итоге оздоровит весь мировой ипотечный рынок.

Ключевые слова: ипотечные кредиты, непрерывность погашения текущей стоимости, новая формула ипотечного рынка, новое решение вопроса ипотеки

JEL: E43, G21, O18

Introduction and the Characteristics of Mortgage Loans

In order to outline a new approach in the mortgage policy first the paper tries to define and present the characteristics of mortgage loans and their impact. We will apply a few a simplified hypotheses and provide a summary for these beforehand.

Based on the data available on the past decades, we examined the trends of annual average reference rates (1 month BUBOR and 1 month LIBOR), inflation, average wage and house price index in Hungary, Germany and the United States. We formed aggregated data on growth for each year by calculating compound interest from the basic data available and based on the data of the first year. We examined the correlations for these data series for each country and observed very high correlation coefficients[1].

[1] Hungary: (BUBOR and inflation; 1996–2017) = 0,9510, (inflation and average wage; 1960–2017) = 0,9918; (inflation and house price index; 1990–2017) = 0,9746. Germany: (LIBOR and inflation; 1987–2017) = 0,9898, (LIBOR and average wage; 1992–2017) = 0,9752; (LIBOR and house price index; 1970–2017) = 0,8007. United States: (LIBOR and inflation; 1987–2017) = 0,9834, (LIBOR and average wage; 1987–2017) = 0,9831; (LIBOR and house price index; 1987–2017) = 0,9776. Data about Hungary was collected from the following sources: [1; 2] and [3; 4]. International data was collected from here: [5; 6; 7; 8; 9; 10; 11] and also [11; 12]. The observed time interval is limited to the data that currently exists, and that can be found online.

Naturally, this did not come as a surprise, as prices change for almost everything in life, and just as the correlation coefficient portrays it, this shows a strong covariance for the examined data series. After two or three decades, the fluctuations of shorter time periods even out and the data series exhibit an order among the examined variables. We observed the following increasing relational order: Hungary: inflation < house price index < reference rate < average wage. United States: inflation ≈ average wage < house price index ≈ reference rate. Germany: house price index < inflation < reference rate ≈ average wage. The "almost equal to" sign (≈) is applied when the average annual deviation was less than 0.2%. Based on the aggregated data series, we must mention that the average annual difference between data series with the smallest and largest growth did not reach 2%, i. e. in the long term average wage increase usually moves together with the 1-month reference rate and house price index.

Due to the strong correlation between these data series, from here on, when modelling and deducing conclusions, we will assume that the percentile changes of the above mentioned four data are identical.

The characteristics of the repayments of classic annuity loans

A popular purpose of financial calculations is determining the annuity-based, fixed-amount repayments on loans. According to university textbooks, this should be deduced from annuity, reaching the following result (for consistency with later sections, *r* is the reference interest rate, *m* is the interest margin of the loan and let $R = r + m$, while *n is the number of repayments*, often expressed in time units):

$$\text{Repayment} = \frac{\text{Amount borrowed}}{\frac{1}{R} - \frac{1}{R(1+R)^n}}. \quad (1)$$

We may also arrive at the result in (1) through the following, more unusual method:

The amount borrowed is precisely equal to the present value of the repayments (X_i) discounted by $R = r + m$

$$\text{Amount borrowed} = \sum_{i=1}^{n} \frac{X_i}{(1+R)^i}. \quad (2)$$

For annuity repayment, the repayments are expected to be equal, so

$$X_i = X_j = X. \quad (3)$$

Form and sum formula of the general geometric sequence:

$$S_n = a_1 \sum_{i=1}^{n} q^{i-1} = a_1 \times \frac{q^n - 1}{q - 1}. \quad (4)$$

X can be isolated from formula (2) because of its equivalence with (3) and furthermore, in this case, based on the $a_1 = q = \frac{1}{1+R}$ relationships:

$$\text{Amount borrowed} = X \times \frac{1}{1+R} \times \frac{\left(\frac{1}{1+R}\right)^n - 1}{\frac{1}{1+R} - 1}, \quad (5)$$

of which X is the following (left) and then after having done the trivial simplifications (right):

$$X = \frac{\text{Amount borrowed} \times (1+R)\left(\frac{1}{1+R} - 1\right)}{\left(\frac{1}{1+R}\right)^n - 1} = \frac{-\text{Amount borrowed} * R}{\left(\frac{1}{1+R}\right)^n - 1}. \tag{6}$$

The equivalence of formulas (1) and (6) can be shown with the following rearrangement:

$$\frac{1}{\frac{1}{R} - \frac{1}{R(1+R)^n}} = \frac{-R}{\left(\frac{1}{1+R}\right)^n - 1}. \tag{7}$$

With both sides rearranged:

$$\frac{1}{\frac{1}{R} \times \left(1 - \frac{1}{(1+R)^n}\right)} = \frac{R}{-\frac{1}{(1+R)^n} + 1}. \tag{8}$$

Dividing by the fraction $1/R$, the left hand side is equivalent to multiplying by R on the right as the reciprocal, and thus the two numerators and the two denominators are the same, so the two sides are equal.

This confirms the equivalence of formulas (1) and (6). This proof was not gratuitous, as it prepares the ground for the later derivations and harmonization with the results.

The nominal and net present values (NPV) of classic annuity repayments, discounted by *r*, are shown in *Figure 1* in the context of a specific example. The interest rates here, and in what follows, are shown on a p.a. (per annum) basis, and the amount borrowed is denoted by *H*.

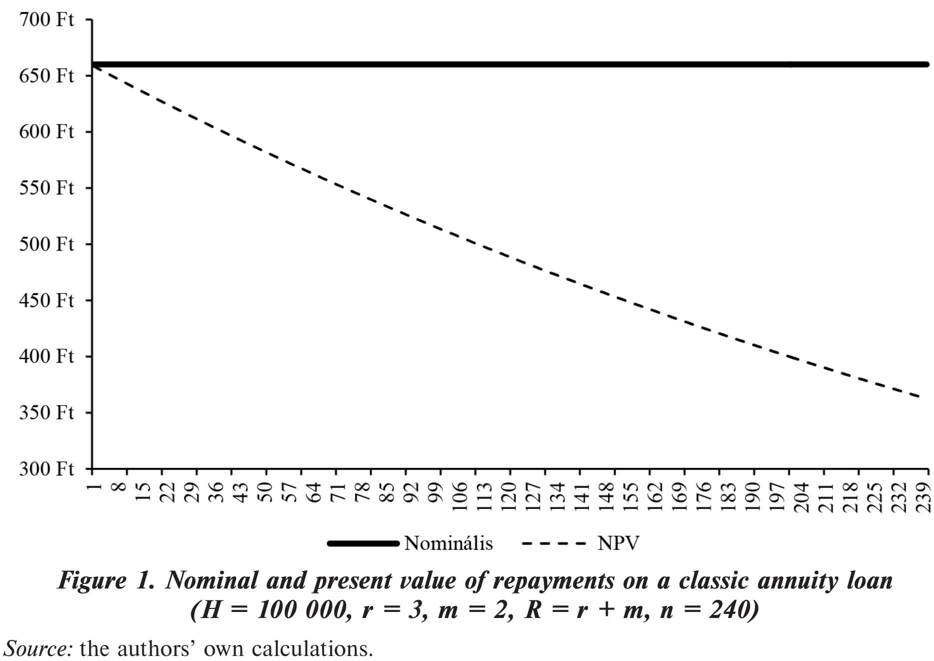

Figure 1. Nominal and present value of repayments on a classic annuity loan (H = 100 000, r = 3, m = 2, R = r + m, n = 240)

Source: the authors' own calculations.

As the chart shows, the "price" of having nominally equal repayments is that the initial repayment is relatively high; then as time passes, the monthly repayment burden continues to depreciate with inflation due to the presence of the discount factor. If the work wages of home buyers increases faster than what the assumed rate of growth for average wage is in the model (due to a promotion or the recognition of considerable work experience, for example), and assuming that the cost of furnishing the home and the extra cost of having children also falls onto the time period directly after the home is bought, then the repayment parameters of mortgage loans run counter to the consumer life cycle, since they overburden young home buyers in the years following the home purchase, then later, in the second half of the term, they become negligible relative to the household's financial capacity. The situation is similar for investment loans, as the new investment causes the company's income-generating capacity to increase as time progresses, while the loan burden decreases contrary to this. In other words, here, the borrower is also overburdened during the initial period and under-burdened in the closing period.

The impact of the interest rate change on the repayment is shown in Function (1), that is, the total derivative function of (1) with respect to *R*:

$$X'(R) = -\text{Amount borrowed} \times \frac{\dfrac{-1}{R^2} + \dfrac{1}{R^2(1+R)^n} + \dfrac{n}{R(1+R)^{n+1}}}{\left(\dfrac{1}{R} - \dfrac{1}{R[1+R]^n}\right)^2}. \tag{9}$$

This risk of significant impact is also demonstrated in *Table 1* and *Figure 2*.

Table 1

Interest rate dependency of annuity loan repayments (amount borrowed: HUF 100 000, terms 240 months)

Interest (*R*) (percent)	**Instalment (HUF)**	**Nominal increase (HUF)**	**Percentile increase**
0	417		
1	460	43	9,40
2	506	46	9,09
3	555	49	8,78
4	606	51	8,48
5	660	54	8,18
6	716	56	7,88
7	775	59	7,59
8	836	61	7,31
9	900	63	7,03
10	965	65	6,77

Source: the authors' own calculations.

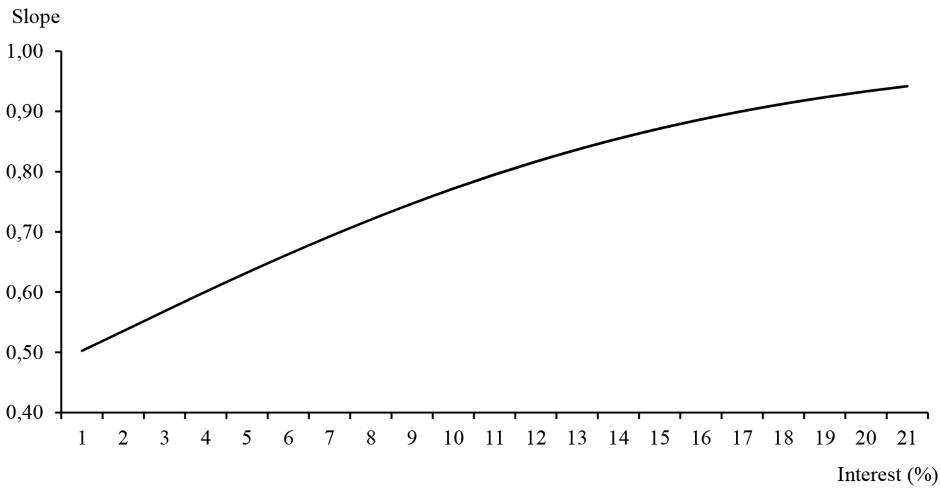

Figure 2. Slope of the repayments of an annuity loan according to interest based on Formula (9) (H = 1, R = 0–20, n = 240)

Source: the authors' own calculations.

As demonstrated in *Table 1,* the impact of the 1 percentage point increase in the interest rate on the sum of the repayment is exponential: 6-8 times the interest rate increase, at normal interest level! The derived function also demonstrates the same, fast increase.

Another thing we can observe from *Figure 1* (which is convex) is that a change in the interest rate, staying within the limits of market reality, influences the repayment to such an extent that if the interest rate environment lurches out of control it may actually cause social problems.

Due to the lender's risks, we should also look at the value and the present value of the outstanding principal debt during the term. Remaining with the previous specific example, this is shown in *Figure 3.*

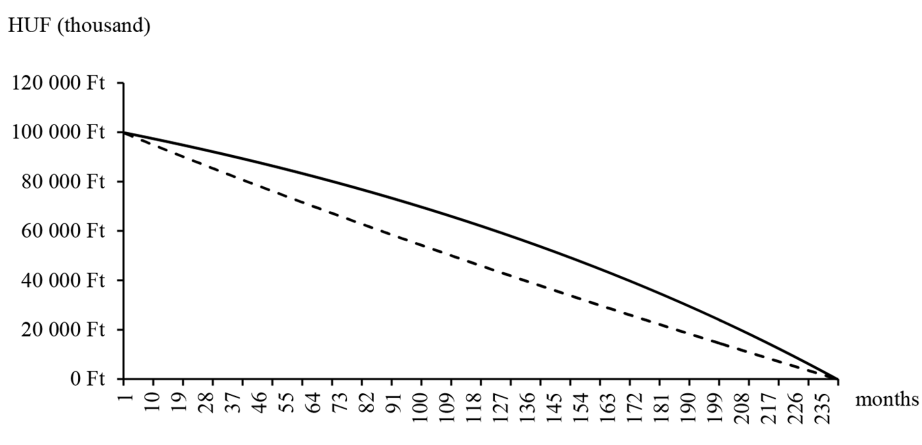

Figure 3. Change in the nominal and present value of the outstanding principal of a classic annuity loan (H = 100 thousand, r = 3, m = 2, n = 240)

Source: the authors' own calculations.

As expected, the outstanding principal – due to the initial overburdening – decreases rapidly. To conclude, we must observe that for countries with a traditionally higher level of interest and countries in danger of struggling with significantly raised interest rates, a new repayment calculation method that is more favorable for consumers should be created instead of the currently applied classic annuity loan repayment calculation i.e. which is nominally determined in national currency. The goal is to keep the repayment affordable for society throughout the entire term. An essential part of this is to significantly moderate the interest rate change impact for new repayment calculation.

Mortgage loans with a constant present value

Based on the global overview of the situation of the mortgage market a prerequisite for the widespread uptake of mortgage is that the reference interest rate should be relatively low (based on general experience, below 10 percent, because above this the starting monthly repayment is unaffordable for society as a whole), and if possible, interest rates should not be volatile.

This is why, in the past, mortgage loans based on an intermediary currency (e.g. Swiss franc, US dollar) became widespread in several Central and Eastern European and South American countries. The initial repayments were much lower for the loans, and the expected amortization characteristics (based on their quick market uptake and popularity)[2] were more in line with the (previously described) consumer life cycle and needs. This is because the forint counter value burden of the nominally constant foreign currency repayment was determined by the combined impact of the rise in the exchange rate and the forint discount factor, which generally present themselves contrary to each other. If these two canceled each other out, repayments became nearly constant in terms of their present value.

Due to the economic crisis however, a dramatic deterioration in the exchange rates of precisely these currencies, and in the USA the introduction of the right to walk away – as the root cause of its collapse – decimated the mortgage market. Regarding the change in exchange rates, several studies have been conducted, such as that of a practical and theoretical comparison of loan burdens with regard to the Swiss franc/Hungarian forint exchange rate [13; 14; 15]. All of these studies concluded that due to the possible extreme market impacts and lack of an optimal intermediary currency, it is impossible to build a stable mortgage market on an intermediary currency-type solution (e.g. Swiss franc, US dollar). Although, it should also be mentioned that, aiming for the optimal amortization characteristics, it would also have been possible to introduce a satisfactory amortization formula – through the mathematical and optimal mirroring of foreign currency-based loans – based on the countries' own national currencies.

The Formula of the Ideal Mortgage Loan Based on the Intermediary Foreign Currency Analogy. If the mortgage loan were to be taken out by means of a conversion to an ideal, base rate-free currency ($k = 0$), the exchange rate of

[2] For example in Central and Easter European countries applying intermediary currency for mortgage loans, the ratio of these foreign currency loans was around 70% of all new loans between 2003 and 2008 [16].

which were to be determined based exactly on the reference rate of the national currency, then the monthly burden of the debt, converted to the intermediary, ideal currency, would start lower, and the repayment burden, also calculated in the intermediary currency, would be nearly constant nominally based on annuity. However, repayments in the national currency that the loan was borrowed in increases constantly and exactly by the amount that is due from the exchange rate increase, calculated based on the reference rate, which will be identical to inflation (for this, please observe the 0,951 correlation coefficient mentioned in footnote 5!). As we mentioned concerning correlations, based on the relationship of *average inflation ≤ average wage increase*, monthly repayments will remain a shrinking part of future monthly incomes (if incomes do not rise, then an equal part).

According to the above, the following is the formula for the intermediary currency (because of $r = 0$):

$$\text{Repayment in the ideal foreign currency} = \frac{\text{Amount borrowed}}{\left(\frac{1}{m} - \frac{1}{m(1+m)^n}\right)}. \tag{10}$$

We arrive at the change in the exchange rate based on the equality requirements for future repayment values. If "right now" the unit price of the ideal currency is HUF X and since in one year's time the HUF mortgage will increase by $(l + k + m)$ times, while the ideal currency will increase by $(l + m)$ times, a year from now the exchange rate will be $X(l + k + m)/(l + m)$, in other words the exchange rate will change to $(l + k + m)/(l + m)$ times what it was. Expressing the repayment from the formula and introducing the change in the exchange rate, if we express the i^{th} repayment in national currency, we receive formula (11):

$$X_i = \frac{\text{Amount borrowed} \times \left(\frac{1+r+m}{1+m}\right)^i}{\left(\frac{1}{m} - \frac{1}{m(1+m)^n}\right)}. \tag{11}$$

Naturally, such an ideal foreign currency does not exist, but there is no need for it in the ideal foreign currency model either! The formula defining the repayment (9) correlates very well with the formula that is constant in present value ($\rho > 0{,}999$). That is why we will depict this in a graph and will not analyze it any further, but will do these later on, after having gotten the results of the next section. If there hadn't been a world economic crisis in 2008 and the Swiss franc, which was considered to be a safe reserve currency, wouldn't have significantly appreciated, then people with foreign currency denominated loans could be enjoying the benefits of a mortgage nearly constant in its present value, i.e. in monthly repayment, to this day.

The Formula of the Optimal Mortgage Loan Facility (precisely constant in present value). We can find the optimal mortgage amortization process, where it is not the nominal, but the present value of the repayments that is constant, based on the logic of the derivation presented at the beginning of the previous section:

The amount borrowed is precisely equal to the present value of the repayments (X_i) discounted by $r + m$, that is

$$\text{Amount borrowed} = \sum_{i=1}^{n} \frac{X_i}{(1+r+m)^i}. \quad (12)$$

The equality of the repayments discounted by r is given by the relationship in (13):

$$X_i = X_0(1 + r)^i, \quad (13)$$

where X_0 is the present value of the repayment calculated for the time of borrowing (it is important to mention that the constant growth at z value for repayment can also be reached by putting $1 + r + z$ inside the parentheses. This may be significant in the case of corporate investments.) Substituted into the previous formula:

$$\text{Amount borrowed} = \sum_{i=1}^{n} \frac{X_0(1+r)^i}{(1+r+m)^i}.$$

Form and sum formula of the general geometric sequence

$$S_n = a_1 \sum_{i=1}^{n} q^{i-1} = a_1 \times \frac{q^n - 1}{q - 1} \quad (14)$$

in formula (14) $q = a_1 = \frac{1+r}{1+r+m}$, based on these relationships and following the isolation of X_0

$$\text{Amount borrowed} = X_0 \times \frac{1+r}{1+r+m} \times \frac{\left(\frac{1+r}{1+r+m}\right)^n - 1}{\frac{1+r}{1+r+m} - 1}. \quad (15)$$

From this after the restoration of X_i from formula (13) following by simplifications, expressing the i-th repayment:

$$X_i = \frac{\text{Amount borrowed} \times [1+r]^i}{\frac{1+r}{1+r+m} \times \frac{\left(\frac{1+r}{1+r+m}\right)^n - 1}{\frac{1+r}{1+r+m} - 1}} = \frac{-\text{Amount borrowed} \times \text{m}(1+r)^{i-1}}{\left(\frac{1+r}{1+r+m}\right)^n - 1}. \quad (16)$$

In other words, with this optimal repayment determination, the present value of every repayment will be the same. Staying with the same example, the nominal and present value of the repayments are shown in *Figure 4* and specific values are shown in *Table F2 in the Appendix*.

The significance of this result is that the repayment burden of the mortgage loan, provided that the borrower's income is constant in value (e.g. if it continuously rises with the reference interest rate – though let's not forget that the rise in Hungary was triple this value in the past decades), will remain consistent. In other words, it will not be an excessive burden in the initial period (using the same example HUF 506 instead of HUF 660), although the repayments will not depreciate with inflation during the closing period. For example, if someone makes a living panning for gold (by which we mean any occupation providing a stable income!), then if they have to plan for one week every month to meet the monthly repayment, they would have to do the same for precisely one week each month throughout the entire term of the loan.

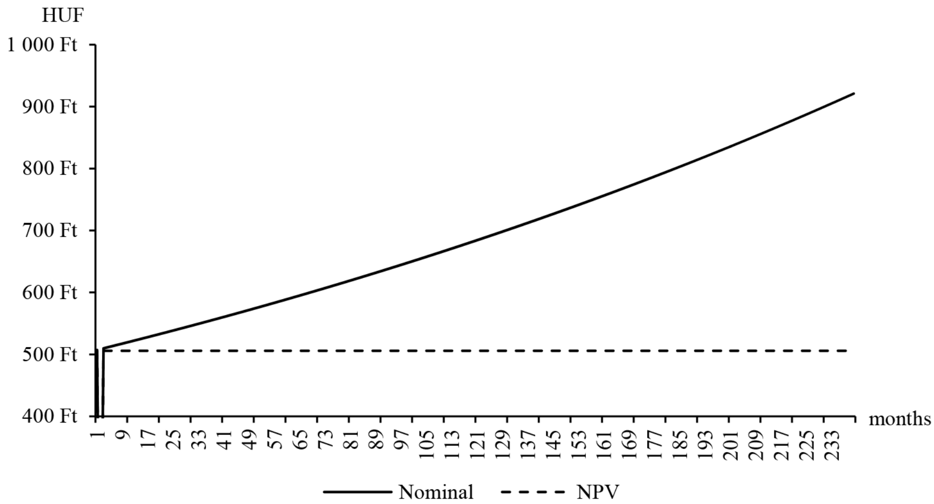

Figure 4. Nominal and present value of optimal mortgage loan repayments (H = 100 thousand, r = 3, m = 2, n = 240)

Source: by author.

Another result of the formula is that it means mortgage lending could also be introduced/applied in countries struggling with high interest rates – e.g. those that formerly resorted to the aforementioned foreign-currency mortgage loans – in such a way that the repayments remain affordable throughout the full term of the loan (identical percentage-wise in proportion to wages only growing at the rate of inflation).

The total derivative of formula (17) with respect to *r* shows the dependency of repayments on the reference interest rate:

$$X'(r)=\frac{Hm(1+r)^{i+2}\left[(1-i)(1+r+m)\left(\left(\frac{1+r}{1+r+m}\right)^{n}-1\right)+nm\left(\frac{1+r}{1+r+m}\right)^{n}\right]}{(1+r+m)\left(\left(\frac{1+r}{1+r+m}\right)^{n}-1\right)^{2}}. \qquad (17)$$

The initial monthly repayments – since we do not know the repayment further on – e.g. with a 20-year term and 2% interest margin will amount to 0.5% of the sum borrowed, regardless of the reference interest rate. This is the result of the fact that in the case of a specific example the change in interest appears as a fixed sum in the sum of repayments (you may observe these in *Table 2*[3] and *Figure 5*). This characteristic remains throughout the entire term, since – as is visible in *Figure* 6 – the curve of the slope of the repayment according to interest becomes almost linear towards the 60th month.

[3] If we compare *Table 2* to *Table 1*, in terms of data we must consider that the present table starts from a 0 percent reference rate + 2 percent interest margin, which would be equal to the *R* = percentage level in *Table 1.*

Table 2

Interest rate dependency of the first monthly repayment on the optimal mortgage loan (H = 100 thousand, m = 2, n = 240)

Reference rate (percent)	1st Repayment (HUF)	Nominal increase (HUF)	Increase in percentages
0	505,8833		
1	506,3049	0,4216	0,0833
2	506,7265	0,4216	0,0833
3	507,1480	0,4216	0,0832
4	507,5696	0,4216	0,0831
5	507,9912	0,4216	0,0831
6	508,4128	0,4216	0,0830
7	508,8343	0,4216	0,0829
8	509,2559	0,4216	0,0829
9	509,6775	0,4216	0,0828
10	510,0990	0,4216	0,0827

Source: the authors' own calculations.

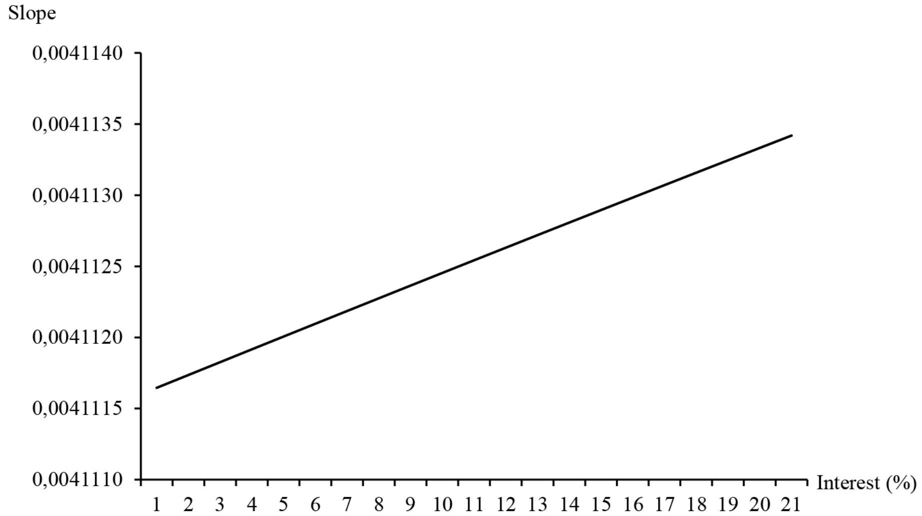

Figure 5. The interest slope of the first monthly repayment of the optimal mortgage, based on Formula (15) (H = 1, r = 0 – 20, m = 2, n = 240)

Source: the authors' own calculations.

Therefore, with this method, the risk of a change in interest rate is reflected in a more moderate increase in repayment, which is a complex function of the variables. These concave (!) functions – given the specific interest rates and terms – can be approached very well using a linear function [4].

[4] When applied in practice, the recalculation of the repayment will result in even more favorable change in repayment, due to the decrease of the loan sum over time.

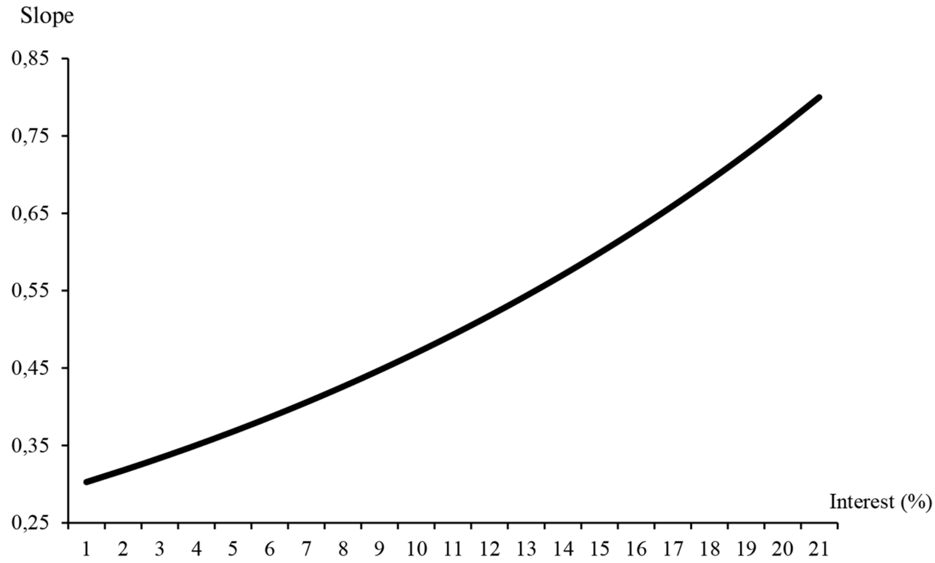

Figure 6. The interest slope of the 60th monthly repayment of the optimal mortgage based on Formula (15) (H = 1, r = 0–20, m = 2, n = 240)

Source: the authors' own calculations.

An examination of the outstanding principal cannot be omitted here either. Continuing to use this specific example, the nominal and present value of the outstanding principal is shown in *Figure 7*.

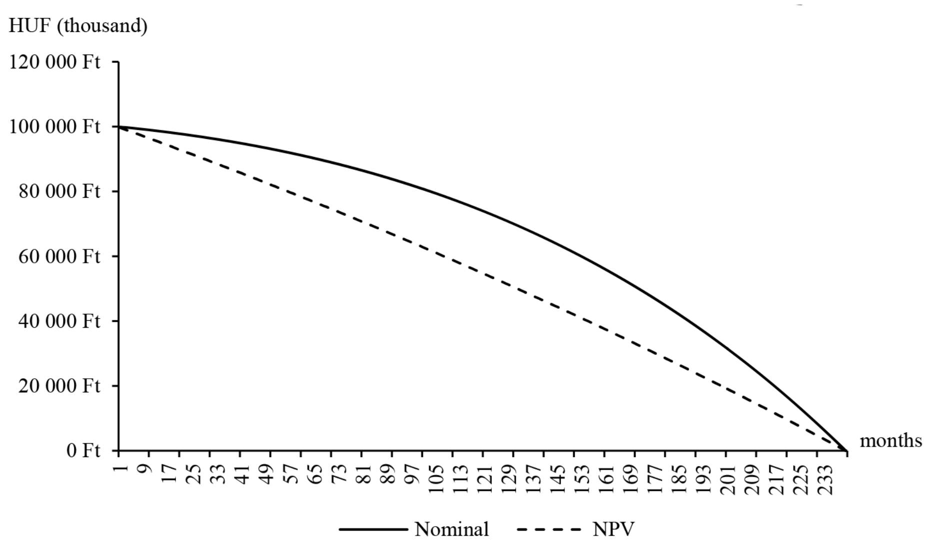

Figure 7. Change in nominal and present value of optimal mortgage loan principal (H = 100 thousand, r = 3, m = 2, R = r + m, n = 240)

Source: the authors' own calculations.

In comparison to *Figure 3*, while observing the curve of the lines depicted we can see that the decrease in principal takes place slower than in the case of a classic annuity loan. For the creditor institution this means that the principal remains outstanding for a longer period of time, and therefore exposure to credit risk is overall greater during the loan term.

Potential Social-Policy Implications

After the 2008 crisis, central banks almost uniformly lowered the central bank reference rates in order to boost the economy. As a result of this, money market interest levels decreased to a record low for a long time, very nearly to zero. Persistently low interest levels for mortgages were extraordinarily inviting, since repayments also fell to a record low. Based on our experience and the global situation of which an overview was provided at the start of this study, we know that mortgage loans can spread in the place and time of economic and political stability, and that the banking sector operates well in a predictable environment and where the reference rate stays persistently between 0 to 10 percent. Also, this is the only way that buying a home with a mortgage can become a realistic alternative to renting in cases where the down payment is significantly lacking[5]. If the reference rate is above 10 percent, then for a supposed buy of real estate without down payment, the monthly repayment of mortgages is considerably more than what one would pay for rent alternatively, which is usually around 0,8-1% of the value of the real estate[6]. If monthly repayments noticeably exceed rent, mortgage lending will not be chosen as an option. In other words, homes will not be bought through mortgage loans.

It is worth weighing the pros and cons of loan facilities using the optimal formula. Their advantage is that they make it possible to determine a payment burden that is either constant throughout the term, or aligned with projected revenue growth. If the interest rate is fixed until maturity, then the regular repayment obligation can also be determined in advance for the full term. If the loan is provided on a variable-interest basis, then the mid-term changes in interest are reflected in the repayments in a way that is effectively linear and matches the extent of the change in interest.

It could be seen as a disadvantage that, unlike the facilities we have been accustomed to, the repayments do not depreciate with inflation. In addition, repayment will increase from one month to the next even if the interest rate remains unchanged. From the banks' perspective, the duration of the loan receivable is longer, which is a disadvantage if payment discipline is bad, but

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[5] From the point of view of investment, to make the final decision to buy or rent, one should examine the Price-to-Rent (P/R) ratio. The rule of thumb is that if the P/R is between 1 and 15, it's worth it to buy, if the P/R is above 15, then it is better to rent. However, it is also important to note that this ratio depicts a state based on current data, therefore we would not want to encourage anyone to buy real estate in Detroit, MI instead of Los Angeles, CA based on this ratio.

[6] According to relevant statistics the price of rent in the United States in the years before the crisis of 2008 was about 1% of real estate prices based as a general rule of thumb. According to several studies [17; 18] and relevant statistics (Case-Schiller Composite 20 and CoreLogic HPI (NSA) this value temporarily rose to nearly 1,5%, then fell once again to a range of between 1-1,2%. However, it is also important that in the continent of Europe this ratio is generally under 1%, the primary reason for which is that this rate is distorted by government and housing cooperative rent fees to seem lower. In half of European countries and over 50% of flats are rented below the market price [19].

an advantage in the case of good payment discipline. Moreover, not even the optimal methods are capable of managing the drop in income that results from the loss of a job, the freezing of income levels during an economic crisis or extreme volatility in individual property markets, etc.

In summary, as demonstrated with the above conditions, the benefits are desirable from the point of view of consumer protection, while the drawbacks are typically less disadvantageous than those of the customary annuity facilities.

We have shown that, irrespective of the reference interest rate, the initial repayment of HUF 100 thousand mortgage loan with a 20-year term and a 2 percent margin is around HUF 500, in other words 0,5 percent of the loan principal[7]. Meanwhile, rent is around 0,8–1 percent of the property's value. Therefore, given a mortgage loan facility that provides sufficient lender protection, even for a property purchase with no upfront payment, the monthly repayment remains less than the rent would be. The latter statement will remain true in the next two decades if, in accordance with the previously set parameters, property prices, rent and incomes, and thus repayments, move together, e.g. they follow inflation[8]. This optimal mortgage facility could also be used globally to resolve the acquisition of property among the Earth's population, and would basically be independent from the interest rate level of individual regions.

Conclusions and Suggestions

As we pointed out at the beginning of this study during our global overview of mortgage loan markets, compared to the real estate needs of the world the reference rate is inherently higher in certain continents/regions of the globe, and since interest rate fluctuation is typical of several continents/regions, the need arises for mortgage loan facilities which are based on a new methodology. The reason for this is that the issue of interest fluctuations (in its traditional sense, viz. according to variable interest facilities) is not being handled. The currently applied classic annuity mortgage loan facilities do not guarantee a predictable alternative solution to renting for access to housing with regard to the entire term, due to their sensitivity to the interest rate. Meanwhile the housing situations in several poorer countries continue to deteriorate as their populations increase at a rapid rate. Based on the repayment parameters depicted, classic mortgage loans overburden young families in their initial period, while their advantages only become apparent towards their closing period, as the repayment depreciates with inflation. This trend is contrary to the natural human cycle, where as people gain more work experience they earn more money from their jobs, and where families' expenses decrease as their children grow up and become adults. Due to this trend, instead of becoming homeowners, many are left with renting as their only choice for housing, especially if they are unable to put up a substantial down payment.

Having detected the increasing number of challenges, we are defining a new, previously unknown mortgage loan facility, which is calculated based on

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[7] 0,6% at a 4% interest margin.

[8] Many people regard following inflation trivial, however relationships should be observed more carefully, including the connection between real estate prices and income [20]. We have already depicted these interactions in the study with regard to data on the past.

national currency. First, we discussed the ideal intermediary currency option, then the result of a mathematical derivation, the aim of which was to have the present value of the repayment be constant instead of the nominal repayment. Based on the two defined (basically coinciding) formulas, the starter repayment primarily depends on the interest margin and not on the reference interest rate. Later repayments always increase by the reference rate value. Throughout the term, interest risk, i.e. the impact of the change in the interest rate, appears in repayments exactly and only to this extent.

The repayment formula defined for the present value of the optimal, constant repayment:

$$X_i = \frac{\text{-Amount borrowed} \times m\left[1+r\right]^{i-1}}{\left(\frac{1+r}{1+r+m}\right)^n - 1}. \quad (18)$$

The introduction of the new mortgage lending formula shown above would have an extensive social impact, since it would, from a financial perspective, provide a way for home ownership as an alternative to renting, even in countries with high interest rate levels. This by itself could be a significant step towards the global rise of the middle class. This is why it is worthwhile considering the introduction of this mortgage facility at the periodical reviewing of current practices and regulations.

Appendix

Table F1

A general overview of the housing loan markets of some countries of the world in June 2018

Country	Mortgage loan interest (percent)	Central bank reference rate (percent)	Rate of inflation (percent)	Average net monthly wage (dollar)	Average house price/wage	Mortgage loan as a percentage of wage	Housing Affordability Index (HAI)*
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Argentina	26,2	40	26,4	657	10,68	286	0,35
Australia	4,5	1,5	1,9	3114	7,41	56	1,78
Brazil	11,5	6,5	2,9	483	16,26	216	0,46
South Africa	10,5	6,5	4,5	1153	3,49	42	2,39
United States of America	4,3	2	2,8	2983	3,34	24	4,15
United Arab Emirates	4,0	2,25	3,5	3067	4,88	36	2,79
United Kingdom	3,2	0,5	2,4	2392	9,31	63	1,58
Egypt	15,4	16,75	11,5	164	12,68	208	0,48
France	1,9	0	2	2184	9,93	61	1,65
India	9,6	6,25	4,9	517	9,73	112	0,89

* HAI *(Housing Affordability Index)*: The index shows the ratio of the income of a household with two average wage earners to the income that is needed for buying an average-sized apartment (65 m^2) with a mortgage. The parameters of the loan product stay unchanged, with the exception of the interest rate. LTV = 70 percent, PTI = 30 percent, maturity = 1year

Source: https://www.numbeo.com/property-investment.

Table F1

1	2	3	4	5	6	7	8
Japan	1,2	-0,1	0,6	2534	12,64	71	1,41
Canada	3,2	1,25	2,2	2320	6,12	40	2,47
China	5,0	4,35	1,8	956	28,2	224	0,45
Poland	3,8	1,5	1,7	889	9,77	70	1,44
Hungary	5,4	0,9	2,8	688	13,32	113	0,89
Mexico	11,2	7,5	4,5	457	7,8	97	1,03
Germany	1,9	0	2,2	2545	8,05	48	2,07
Italy	2,4	0	1	1749	9,88	63	1,58
Russia	11,5	7,25	2,4	578	11,44	155	0,65
Romania	3,4	2,5	5,4	654	9,1	63	1,6
Spain	2,3	0	2,1	1517	8	50	2,01
Sweden	2,5	-0,5	1,9	2547	10,52	63	1,59
Singapore	2,2	1,12	0,1	3067	22,2	139	0,72
Turkey	13,5	17,75	12,2	504	8,95	124	0,81

Table F2

Amortization Schedule (H = 100 000, r = 3, m = 2, $R = r + m$, n = 240)

Month	With classic annuity (repayments are nominally constant)						Optimal formula (NPV of repayments is constant)					
	Monthly repayment	NPV Monthly repayment	Interest	Principal	Principal remaining	NPV Principal remaining	Monthly repayment	NPV Monthly repayment	Interest	Principa	Principal remaining	NPV Principal remaining
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1	660	658	417	243	99 757	99 508	507	506	417	90	99 910	99 661
2	660	657	416	244	99 512	99 017	508	506	416	92	99 818	99 321
3	660	655	415	245	99 267	98 526	509	506	416	94	99 724	98 980
4	660	653	414	246	99 021	98 037	511	506	416	95	99 629	98 639
5	660	652	413	247	98 773	97 548	512	506	415	97	99 532	98 297
. . .												
101	660	513	291	369	69 527	54 029	651	506	338	313	80 696	62 709
102	660	512	290	370	69 156	53607	652	506	336	316	80 380	62 307
103	660	510	288	372	68 785	53 186	654	506	335	319	80 060	61 905
104	660	509	287	373	68 411	52 766	656	506	334	322	79 738	61 502

Source: the authors' own calculations.

Table F2

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
105	660	508	285	375	68 036	52 346	657	506	332	325	79 414	61 099
106	**660**	506	283	376	67 660	51 926	**659**	506	331	328	79 086	60 695
107	**660**	505	282	378	67 282	51507	**661**	506	330	331	78 755	60 290
108	660	504	280	380	66 902	51 089	662	506	328	334	78 421	59 885
109	660	503	279	381	66 521	50 671	664	506	327	337	78 083	59 479
110	660	501	277	383	66 138	50 254	665	506	325	340	77 743	59 072
111	660	500	276	384	65 754	49 837	667	506	324	343	77 400	58 665
112	660	499	274	386	65 368	49 421	669	506	323	346	77 054	58 256
. . .												
235	660	367	16	644	3 259	1 812	909	506	23	887	4 524	2 516
236	660	366	14	646	2 613	1 449	912	506	19	893	3 631	2 014
237	660	365	11	649	1 963	1 086	914	506	15	899	2 732	1 512
238	660	364	8	652	1 312	724	916	506	11	905	1 828	1 009
239	660	363	5	654	657	362	918	506	8	911	917	505
240	660	362	3	657	0	0	921	506	4	917	0	0

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CHARACTERISTIC OF MORTGAGE LOANS AND A NEW SOLUTION

As the population of the world continues to grow and living standards continue to improve, we must find an adequate solution for housing issues. The first part of this paper tried to shed more light on the drawbacks and the past anomalies of the world mortgage market. We observed different continents and tried to point out the main causes behind the bottlenecks of mortgage markets. The reasons varied across countries but some similarities emerged, such as that in the initial period repayments places a huge financial burden on households. The second part of the paper introduces a new mortgage market formula which is based on the concept of "continuity of the present value of the repayments". This solution provides lower and, in present value terms, even initial monthly repayments for the borrower. The new approach offers an alternative to renting and could serve as a good tool to help achieve home ownership, as well as lead to a healthier global mortgage market.

Keywords: continuity of present value repayments, mortgage loans, new mortgage market formula, a new solution

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