Effect of the Yield Level, the Inflation Environment and the Pandemic on the Lapse Rates of Life Insurances*

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This study examines the lapse rates of certain life insurances in relation to various economic and non-economic events, analysing empirical insurance data, in search of answers to the questions of what impact the changed yield and inflation environments and lockdowns due to Covid-19 had on the cancellation of contracts, and how sensitive policyholders are to changes in yields in the case of certain investment-type insurances. In addition to the conclusions drawn on the basis of time series data, further statistical analyses (such as Granger causality testing, contract classification with k-means clustering) contribute to a more complete picture. The effect of certain changes in the interest rate level on lapses can be detected in the case of the single premium investment-type insurance under review (especially for the higher premium classes). No similar behaviour is typical of the current premium insurances under review, and so far it has also not been possible to detect any significant relationship with lapses in connection with inflation or the lockdowns due to Covid-19.

Journal of Economic Literature (JEL) codes: G22, C32, C58, E43

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1. Introduction

Life insurance is a long-term business. The policyholder and the insurance company sign a contract for a long period of time (even for several decades) for an insured event that depends on the insured person's being alive. Both the relevant legislation and the terms and conditions of the insurance contract itself contain the conditions of cancellation and lapse of the insurance. The insurance company is not entitled to cancel a life insurance contract. The policyholder may exercise his/her right of cancellation; each contract determines in what cases, with what effect and under what conditions the contract can be terminated. In the case of life insurances that

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contain an investment element as well (in our study we examine these types of insurances), typically some kind of residual right is also associated with cancellation of the life insurance. The most frequent case is that the policyholder surrenders his/her contract, which means that the contract is terminated definitely, and simultaneously with that the insurance company pays back to the policyholder a certain part of the premium reserve accumulated for the later service from the premiums collected until then. In the case of traditional life insurance products, the insurance company undertakes a long-term interest rate guarantee vis-à-vis its policyholders. It is the so-called technical interest rate, which shows the interest rate undertaken by the insurance company in advance for the coverage accumulated for later services (this is what they call premium reserve). Therefore, the insurance company must make long-term investments. Cancellations of a given type of insurance are very important in terms of yields and liquidity, and the lapse rates are also of crucial importance in terms of the cash flows (e.g. insurance premiums, insurance service payments, costs, etc.) that affect the insurance company's long-term profitability. It is not surprising that the statistical analysis of lapses and lapse effects are important subjects in the insurance profession and insurance mathematics (actuarial science). This is also demonstrated by the fact that the so-called standard formula of the Solvency II framework,[1] which regulates insurance companies' solvency capital requirement, also determines a capital requirement for the lapse risk.

In the Hungarian literature, *Hanák* (*2001*) deals in detail with the mathematical model of lapses and the underlying factors. *Janecek* (*2012*) proposes to take into account the underwriting year of the contract, the elapsed time from the beginning of the contract and the type of the product in any case when analysing lapses. Using an empirical sample, *Szepesváry* (*2015*) examined whether the insurance premium and the policyholder's entry age have a significant impact on lapses. The so-called survival models (see, for example, *Vékás 2011*) constitute an accepted methodological basis for analyses of this kind. Where T indicates the time until lapse, the function defined with the formula $G(t) = P(T \geq t)$ is called the survival function, which gives the probability for the individual t points of time that the contract was in-force for at least t months. The two best-known survival models are the Kaplan–Meier estimate and the Cox regression. Explanatory variables may also be involved in the estimate in the case of the latter.

The relationship between external factors and lapses is also analysed in the literature. A related notion is the phenomenon known as dynamic policyholder behaviour (see, for example, *Barsotti et al. 2016*). This refers to the modelling of the

[1] See, for example, *Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II)* (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32009L0138, downloaded: 1 February 2022) or https://www.mnb.hu/felugyelet/szabalyozas/szolvencia-ii (Downloaded: 1 February 2022)

effect that the probability of drawdown of the options available for policyholders (e.g. lapse) may change dynamically in view of the external (e.g. economic) environment. *Campbell et al.* (*2014:47*) highlight two main hypotheses with regard to surrenders. According to the interest rate hypothesis, lapse rates show a negative relationship with internal return (e.g. with the technical interest rate) and a positive relationship with external (e.g. market) interest rates, i.e. if the yield guarantee is high, lapse by policyholders tends to be lower, whereas more policyholders cancel their contracts if other forms of investment offer higher yields. According to the 'emergency fund hypothesis', surrenders mostly take place as a result of difficult financial positions. This study also examines materialisation of the interest rate hypothesis and emergency fund hypothesis in Hungary in certain cases. Using generalised linear modelling, *Kim* (*2005*) estimates the probability of lapse on the basis of the unemployment rate, economic growth, the indicator of the period of financial crisis and the age of the contract. *Poufinas – Michaelide* (*2018*) examine the trends in lapses as a function of various macroeconomic variables (such as unemployment, inflation and interest rates). *Russell et al.* (*2013*) find empirical evidence for materialisation of the interest rate and emergency fund hypotheses. For insurances with profit participation, *Grosen and Jorgensen* (*2000*) examine whether the contract can be decomposed into the sum of a risk-free policy, a bonus option and a surrender option element. *Milhaud et al.* (*2011*) model lapses with logistic regression and decision tree methods. In addition, the Cox regression also has a variant that contains time-dependent covariates as well (see, for example, *Fisher – Lin 1999*), which is a suitable tool for the inclusion of variables related to dynamic policyholder behaviour.

In this study, changes in lapses are examined in relation to external, economic and non-economic events that are similar to the ones described above. We examine, for example, how the change in the yield and inflation levels as well as the lockdowns related to Covid-19 affected the probability of lapse. For this, we examine the time series of lapse rates of traditional single and current premium life insurances that contain an investment element, using graphic and statistical tools as well.

2. Analysed data and their sources

The analysis was prepared on the basis of empirical insurance data. The insurance types listed below are examined in the study. The features of traditional life insurance products are only briefly summarised in the study; one can read about the related traditional techniques in more detail in the book by *Banyár* (*2016*), for example.

- Traditional, regular premium endowment product with technical interest rate and yield surplus participation if the yield exceeds the technical interest rate. In the case of life insurances, the technical interest rate means a kind of guaranteed yield level, for which the insurance company undertakes a guarantee that it will pay at least the interest yield on the premium reserve accumulated from the policyholder's payments. In addition, if the actual yield exceeds the technical interest rate (the surplus is called yield surplus), a portion of that, as determined in the terms and conditions of the contract, is also returned by the insurance company to the policyholder. We examined groups of contracts with 2.25 per cent and 1.6 per cent technical interest rates, where at least 80 per cent of the yield surpluses above these rates are refunded by the insurance company. In addition, the essence of endowment products is that the chosen sum assured is paid by the insurance company even if the insured person survives until the end of the term, but the total amount is also disbursed if the insured person dies during the term. As it is uncertain (and depends on the insured person's being alive) how long the insurance premiums are received and when the total sum assured has to be paid, this scheme contains a material mortality risk, the cover for which is included by the insurance company in the insurance premiums. In the case of death, the beneficiaries of the insurance may even get back a significantly higher amount compared to the premium paid until then. The insurance company deducts cover from the insurance premium for the mortality risk and costs as well, and the rest is invested into the premium reserve (which bears interest as described above), and this will be the basis for future services. If the policyholder does not wish to pay the regular premium after a certain point of time, the current premium reserve will constitute the basis for his/her residual rights. For example, if he/she surrenders his/her contract, the insurance company will refund a certain part of the premium reserve to him/her.

- Current premium investment-type life insurance (pure endowment product with 2.25 per cent or 1.6 per cent technical interest rate and at least 80 per cent yield surplus participation). A scheme similar to the one presented in the previous point, with lower mortality sum. Accordingly, of the investment and mortality risk elements, the investment part dominates in the insurance in this case.

- Current premium pension product (with 2 per cent or 1.6 per cent technical interest rate and at least 80 per cent yield surplus participation). An insurance product similar to the one presented in the previous point, which can be bought by policyholders as savings for retirement. Under certain conditions, pursuant to the prevailing legislation, a 20 per cent tax refund granted by the state can be received on the premiums paid, which may represent an excellent return for the policyholder. However, a high penalty is imposed on the policyholder in the case of surrender, especially in terms of the tax refund.

- Single premium traditional investment-type life insurance, with short-term yield periods fixed in advance. The insurance company announces the short-term yield periods with quarterly frequency, in every case in advance, in the form of yields promised for the individual contracts. Accordingly, not later than until the end of the given month all policyholders may gather information about the yields offered by the insurance company for the next month, and may decide to maintain their savings or surrender them depending on that. Consequently, the expected yield is foreseeable for policyholders for 1–3 months. In the case of surrender, a low penalty burdens policyholders (not even in every case), and thus the policyholder can invest his/her savings in another scheme without any significant sanction. In addition to the investment element, accident insurance services are also included in the contract.

The analysed specific products and contract groups originate from the portfolio of a Hungarian life insurance company. *Due to the limiting of business recognisability, the axes of the figures presented (e.g. lapse rate) are rescaled in the study. Nevertheless, this does not significantly change the interpretations and conclusions.*

The monthly lapse rates of individual products and product groups and their relations with various external and internal circumstances are examined in the period between 2019 and 2021. Lapse rate means the ratio of the contract volume cancelled (surrendered contracts or contracts with terminated premium payment) in the given month to the average in-force portfolio in that month. We quantified lapse rates by policy and by premium. We examine them as a function of the factors listed below.

- How do the external and internal interest rate environments affect the lapses of life insurances?
  - The role of the yield guarantee provided by the technical interest rate, which is also regulated in a Decree of the Magyar Nemzeti Bank (the Central Bank of Hungary, MNB),[2] may appreciate in a low yield environment, whereas in a reverse case it may happen (see the aforementioned interest rate hypothesis) that lapses increase if the available external yields exceed the technical interest rate (and if the policyholder does not receive a high enough portion from the yield surplus either). In view of the strong increase in yields that started in the last months of 2021, this is an important, topical issue in the case of traditional life insurance products.
  - Similarly, in the case of the single premium insurance under review, we examine the impact on lapses of the external yield environment and of the internal short-term interest rates fixed in advance to the portfolio and the individual contracts: how does it affect the lapse rate if the interest rate level promised to the given policyholder declines during the next fixed yield period?

[2] See: https://net.jogtar.hu/jogszabaly?docid=a1500054.mnb

- The external interest rate environment is measured with the 1-, 5- and 10-year benchmark yields of the Government Debt Management Agency (ÁKK),[3] and we also examine the effect exerted by the introduction of a preferential government bond (such as the MÁP+ super government bond[4]) available for households.

- How does the increase in inflation affect the lapse rates of life insurances?

  - Similarly to yields, inflation also increased significantly in the final months of 2021. It may result in a decline in the real value of the savings if the rate of inflation significantly exceeds the interest rate level that can be attained by the insurance. We examine whether the effect of this can be detected in the lapse rates.

- How did the lockdowns related to Covid-19 affect the lapse rates of the life insurance products under review?

  - The book review by *Kovács* (*2021*) presents a comparison of the pandemic and economic crises, highlighting that the unemployment rate and economic uncertainty increased considerably as a result of the pandemic. In this environment, more policyholders may draw on their long-term savings, and thus the probability of lapse of life insurance products may also change.

  - The degree of the restrictions related to Covid-19 are measured with the so-called stringency index.[5] We use the time series for Hungary.

  - It may occur that in the case of greater 'stringency' a greater stratum may need to draw on their savings and surrender their insurances (see the above 'emergency fund hypothesis'). However, a contrasting effect can also be imagined: policyholders may postpone some major expenditures to the period after the end of the pandemic. We examine whether any of the hypotheses had any verifiable effect on the lapse rates.

  - *G. Szabó and Nagy* (*2021*) also examined the continuity of investment-type insurances and their new acquisitions in connection with the lockdowns due to Covid-19 in 2020. They believe that it was a result of the high employment rate and the payment moratorium that not a large number of policyholders needed to free the reserves accumulated in life insurance.

  - The stringency index has already been used in other insurance related studies as well. In their study, *Csépai and Kovács* (*2021*) analysed the ratio of deaths due Covid-19 as a function of the stringency index for various European countries.

[3] See: https://www.akk.hu/statisztika/hozamok-indexek-forgalmi-adatok/referenciahozamok
[4] See: https://www.allampapir.hu/allampapirok/MAPP/
[5] See: https://ourworldindata.org/grapher/covid-stringency-index?tab=chart&region=Europe&country=~HUN

In the analyses presented, first we graphically depict the time series of lapse rates and the above variables for visualisation of the relationship. Very often, the figures are already expressive for analysing the relationship between the variables, but the hypotheses set up are also tested statistically with time series analysis techniques. So-called vector autoregressive models (VAR) and the Granger causality provide the methodological tools for this. In other cases, cross-section data are also analysed in connection with the classification of the individual policyholders, for which the *k*-means clustering provides a statistical basis. The figures were prepared in Microsoft Excel on the basis of the databases. The time series analysis calculations were performed using the Gertl software, while the cross-section data were analysed in the IBM-SPSS software.

The following are highlighted in connection with the selected methodology and the data. Data in monthly breakdown on the number of lapses and volumes of portfolio at the product level were available for the three-year period between 2019 and 2021 for the analyses. Cross-section data for all points of time regarding the contract level portfolio are not available; therefore, for example, the Cox regression with time dependent covariates would not have been feasible on the data. Accordingly, the aim of the analyses is not to prepare a complete model that describes the surrender ratios by mapping all the factors that have an effect on the lapse rates, but rather the examination whether the change in certain circumstances mentioned above (such as yield level, inflation, lockdowns related to the pandemic) had a provable impact on the lapse rates. The applied methodology was chosen in line with the above. First, the time series and lapse statistics were illustrated in a graphic manner, which allows a simple visualisation of the presence of the trends in question from the data. The vector autoregressive models were drawn up and the presence of the Granger causality was tested in order to have stronger statistical evidence than the conclusions drawn from the figures.

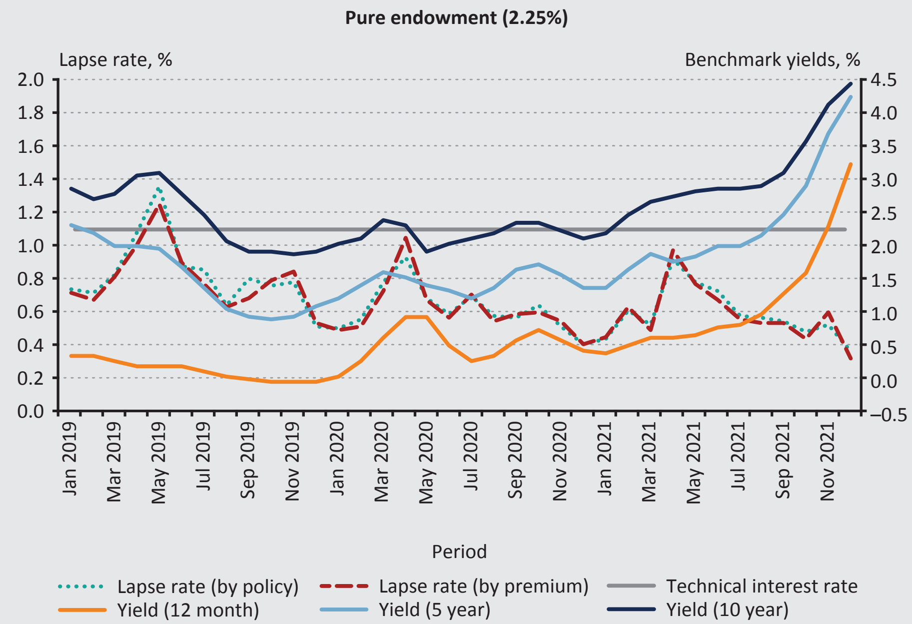
3. Effects of changes in the yield environment on lapses of life insurances

3.1. Relationship between the lapses of current premium insurance products having technical interest rate and the external interest rate environment

We examine the dependence on the external yield environment in the case of the lapses of the current premium insurances presented in *Section 2*. Lapse rates by policy and by premium (scale on the vertical axis on the left side) in a monthly breakdown for the period between 2019 and 2021 as well as the ÁKK benchmark yields and the level of the technical interest rate typical of the product (scale on the vertical axis on the right side) are depicted in one figure. Due to size limitations, not all the related figures are published in the study; in all cases, only some examples are shown. For similar reasons, the results for all of the various technical interest rates are not given either. In the headings of the figures, the percentage value appearing next to the name of the product shows the technical interest rate of the contract group.

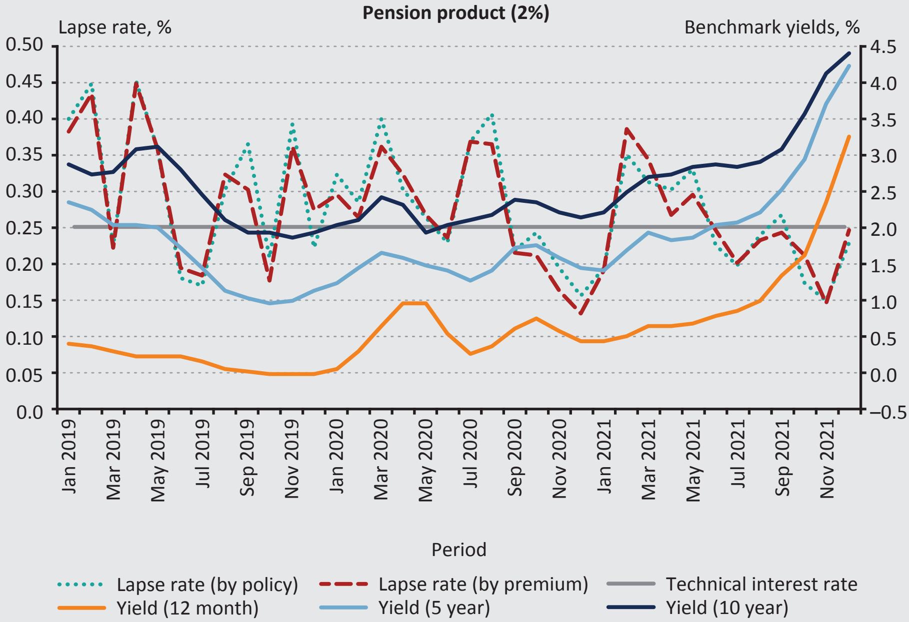
The composition of the portfolios and the volatility observed in the lapse time series in a monthly breakdown were assessed in advance. The composition of portfolios (e.g. number of policies, distribution according to the period since underwriting of the contract, composition according to the size of premium and age) can be considered basically stable in the case of the portfolios under review. Nevertheless, some of the outliers seen in the figures (e.g. *Figures 1* and *2*) are partly justified by the composition of the portfolio (for example, in the first two insurance years or following the insurance anniversaries, the probability of lapse is typically higher; if there were more contracts like that in a given month, the lapse rate is also higher), and partly seasonal effects or other external circumstances may also interfere. Due to the smoothing of these effects, the use of quarterly data instead of monthly data may also arise: the volatility observed in the time series would have declined considerably in the case of pension products and to a lesser degree in the case of current premium investment-type insurances. However, quarterly transformation would result in very short time series, with which the later models would not work well. Therefore, taking everything into account, in the following we analysed the data in a monthly breakdown.

Figure 1
Lapse rates of current premium investment-type insurance (pure endowment product) according to changes in yields



Source: Compiled on the basis of insurer data and benchmark yields of the ÁKK

Figure 2
Lapse rates of pension product according to changes in yields



Sources: Compiled on the basis of insurer data and benchmark yields of the ÁKK

The following conclusions can be drawn on the basis of *Figures 1 and 2*. The rise in benchmark yields that occurred in 2021 H2 did not result in higher lapse rates for the products under review, and no increase was observed even when the level of the attainable interest rate exceeded the technical interest rate. Of course, it can also be attributable to the fact that most of the yield surplus above the technical interest rate is due back to policyholders, and the contract provides long-term guarantee. Nevertheless, it is much more likely that policyholders buy these contracts because they need a long-term life insurance or pension product, where they accumulate savings through regular premium payments, exploiting in the meantime the advantages of the given insurance product, and this is why government bond benchmark yields do not compete with the product (i.e. they do not modify the probability of lapse). On the basis of Insurance Europe's survey, *Lambert* (*2020:104–106*) also arrives at a similar conclusion: in connection with pension savings, he highlights that in Hungary 73 per cent of the respondents prefer safe investments (do not take a risk), while accessibility before retirement (liquidity) and the performance of the investment are less important aspects for the group under review. However, many of the respondents are ready to pay for the additional insurance coverage as well. A further possible explanation might be that financial literacy and the knowledge of products are not sufficiently developed in Hungary, and many policyholders do not have adequate information on the complex yield level provided by the technical interest rate and the yield surplus participation, and they cannot compare that with other investment possibilities. *Kovács and Nagy* (*2022*) write about the financial awareness typical in Hungary, the distribution of the forms of savings and the changes in the former during the pandemic, while the study by *Terták* (*2022*) examines – as a comparison – the financial literacy typical in the world. *Németh-Lékó* (*2020*) emphasises that the inadequate financial awareness of Hungarian households can be confirmed on the basis of international and domestic research as well. For example, it is often typical that financial decisions are not made in a prudent manner, and the ratio of those who consciously compare offers when selecting a financial product is only 30–38 per cent (i.e. below the international average). Although no clear evidence can be found for the above hypotheses in terms of the explanation, it does not change the result that no relationship is observable between lapse rates and benchmark yields.

The above hypothesis is examined with time series analysis methods as well. The study does not provide a detailed presentation of the time series analysis–econometric techniques. The applied methodology was prepared in line with the work of *Kirchgässner et al.* (*2013*), in which one can read more about the methods; the methodological book by *Wooldridge* (*2009*) also presents the related econometric models in detail.

We fit vector autoregressive (VAR) models to the lapse rates and the time series of the benchmark yields. The essence of this is that we consider each variable as an endogenous variable (dependent variable), and explain it with a system of equations where the explanatory variables are the lags of the endogenous variables. For example, in the case of two endogenous variables, X_t and Y_t time series in the case of k maximum lag number equation (1) describes the VAR model (α, β coefficients are constant, ε_1, ε_2 are the residual variables, white noises according to assumption, and t is the time parameter).

$$\begin{aligned} X_t &= \alpha_0 + \alpha_{1,1}X_{t-1} + \cdots + \alpha_{1,k}X_{t-k} + \alpha_{2,1}Y_{t-1} + \cdots + \alpha_{2,k}Y_{t-k} + \varepsilon_{1,t} \\ Y_t &= \beta_0 + \beta_{1,1}X_{t-1} + \cdots + \beta_{1,k}X_{t-k} + \beta_{2,1}Y_{t-1} + \cdots + \beta_{2,k}Y_{t-k} + \varepsilon_{2,t} \end{aligned} \tag{1}$$

According to the definition of the Granger causality, Y_t is the Granger cause of X_t if in the equation stated for X_t the lagged values of time series Y_t have a significant effect on the value of X_t (its coefficients are not zeros), i.e. the past of Y_t contains explanatory power for the present of X_t. The definition does not exclude the examination of the Granger causality of a variable taken on for itself. In this case, a single-variable autoregressive model, which is the one-dimensional equivalent of the VAR model, is also sufficient. In our examples, we examine whether any variable is a Granger cause of the lapse rates, i.e. whether the past of a process affects the value of the lapse rate in a given period, or the dependency can be excluded.

For the examination of the Granger causality, it is necessary that the X_t and Y_t time series be stationary (their expected value and variance should be constant, and their autocovariance function should only depend on the distance of the observations and be constant in time). Stationarity in the Gretl software was examined with the help of the augmented Dickey–Fuller test; the null hypothesis of the test is that the time series is not stationary. In our samples, in the case of the time series under review, the p-value of the test exceeded the usual significance levels (i.e. the hypothesis of non-stationarity was acceptable). In such a case, the differentiation of the time series (creation of differences), i.e. the analysis of the changes in the given time series, is generally accepted practice. In the case of benchmark yields, even the first difference was not sufficient for considering the time series stationary; therefore, we created the second differences uniformly (i.e. for each variable) and included these in the analysis. Accordingly, for the variables under review we received p-values between 0–3 per cent, which we already considered appropriate for the continuation. The disadvantage of the second difference is that it is more difficult to interpret (it shows the change of the change), and thus we did not interpret the coefficients in the equations that were received later.

The VAR equations were estimated after the examination of stationarity. As our time series are short, we always included only two variables simultaneously (a lapse variable and a yield variable) in the estimation. We selected the optimal lag number on the basis of the values of the information criteria offered by Gretl (Bayes information criterion, Hannan–Quinn and the Akaike criteria). On the basis of the indicators, we typically applied maximum lags between 2–6 in the models set up.

Gretl estimates the coefficients with the ordinary least squares method. The software prepares a t-test for the estimated coefficients of the variables, with which the significance of the given variable can be tested. The null hypothesis of the test is that the real value of the coefficient is 0 (and the estimated value is not 0 only because of the random deviation in the sample), i.e. the variable does not have any significant explanatory power. The F-test is created with similar logic, allowing the testing of the null hypothesis, whether, for example, the coefficients of every lagged value of Y_t are zero in the estimate of X_t. If the null hypothesis of the test is acceptable, it means exactly that Y_t is not a Granger cause of X_t.

When the VAR model is ready, it is also worth testing whether the residual variables can be considered white noise. We also did this with the built-in tests of Gretl, but due to space limitations we do not go into details here.

We performed the Granger causality test according to the process presented above for the lapse rates by policy and by premium of the three types of regular premium insurances and the time series of the benchmark yields by pairs. In almost all cases we found that in the case of all usual significance levels the hypothesis of the F-test was acceptable, i.e. the benchmark yield is not a Granger cause of the lapse rate. Interestingly, in some cases (for example, when we examined the lapse rates by premium of the regular premium investment-type insurance with the 10-year benchmark yield in a VAR model), the hypothesis of the F-test could not be accepted, only at a significance level of 1 per cent. Indeed, in the first 30 months some co-movement of the lagged 10-year benchmark yields and the lapse rate is discernible (*Figure 1*), and a further economic argument may be that the lapse rate was mainly higher when the benchmark yield was above the level of the technical interest rate. However, it completely contradicts this hypothesis that in the last 6 months, when the most significant rise in yield took place, the lapse rates did not increase at all. We repeated the analysis for the data of the years 2020 and 2021 only (to give a greater weight to the observation of the last half year); then the null hypothesis of the F-test could already be accepted at all usual significance levels.

It is also to be mentioned that a clear AR effect is often observed on the lapse rate (more exactly on its second difference) on the basis of the obtained equations; the relationship with the past of the time series is significant on the basis of both the t- and F-tests.

On the whole, we also found with statistical methods that in the period under review in the case of the analysed current premium insurances the benchmark yield did not have any significant impact on the lapse rates. However, as only a short time has elapsed since the major change in the yield environment, it could be expedient to repeat this examination later as well, for example in a year's time, if a similarly high yield level also prevails until then. It may also occur that the circumstances change even according to products, and lapse rates increase in the case of the ones where there is no higher insurance coverage or policyholders cannot enjoy the advantage of the tax refund of the pension product. However, the data do not suggest any such effect so far.

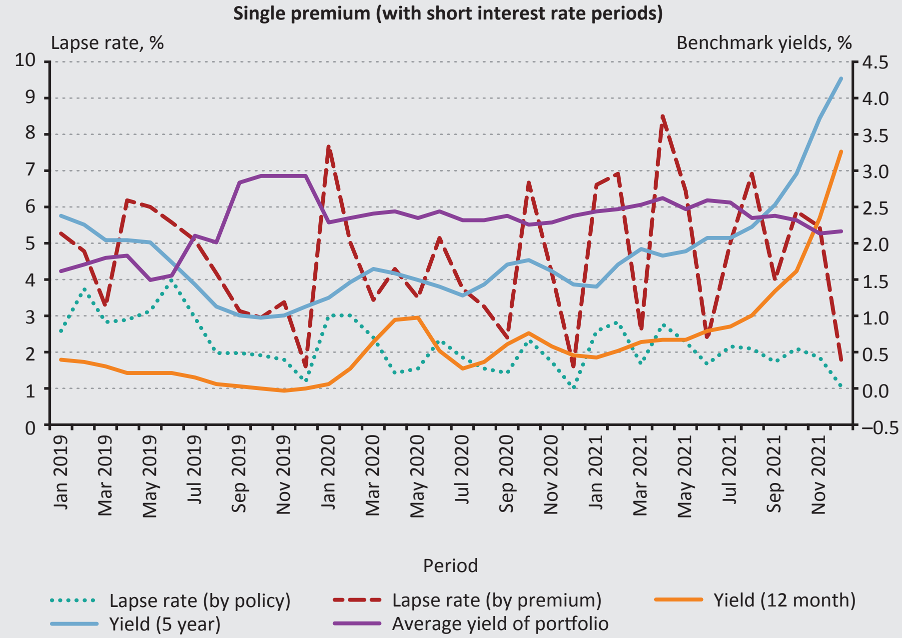
3.2. Lapse rates of the single premium insurance and the relationship between the external and internal interest rate environments

First, we examine the lapse rates of the single premium insurance with the help of *Figure 3*, which is similar to that of the current premium insurances. Instead of the technical interest rate, in this case we depicted the average interest rate level according to the short-term yield periods. As this product type is characterised by shorter duration compared to regular premium insurances, we included only 12-month and 5-year benchmark yields.

Figure 3 does not suggest any dependency between benchmark yields and the lapse rates. The benchmark yield exceeded the average yield of the portfolio in the last months of 2021. However, this effect did not raise the lapse rate of the portfolio at all. No correlation between the lapse rate and the benchmark yield is seen in the previous period either, an explanation for which might be that the average yield of the portfolio in this period was higher than the benchmark yield.

It is remarkable in *Figure 3* that the lapse rate by premium is much higher and much more volatile than the lapse rate by policy. This suggests that the policyholder portfolio is not homogeneous: the size of the premium invested affects the lapse rate, and policyholders with higher amounts of savings are more likely to use the lapse option. In order to be able to better understand the reasons for the volatile behaviour, we examine the impact of the yield level on lapses using data broken down to the level of individual policyholders.

Figure 3
Lapse rates of single premium insurances according to the changes of yields



Source: Compiled on the basis of insurer data and benchmark yields of the ÁKK

We continue the analysis with cross-section data. We examine by contract all the lapse events that took place in the 3-year period. It may be logical that in the case of this product the internal interest rate level and its changes may also play a role in policyholders' decisions (compared to current premium insurances the fluctuation of the internal interest rate level may be greater here than it was in the case of the products with fixed technical interest rate). Therefore, it was assigned to the individual claims[6] how the short-term interest rate announced for the given policyholder changed close to the surrender, in the month before the surrender (r_{t-1}), in the month of the surrender (r_t), and how it would have changed in the month following the surrender if the policyholder had not cancelled the insurance (r_{t+1}). In all cases we use annualised yields. According to the analyses, the $r_{t+1} - r_{t-1}$ quantity has a major impact on the incurred claims. It measures how the yield

[6] Service disbursements or disbursements according to residual right are often called claim in the case of life insurances as well.

level credited to the policyholder would have changed if he/she had not cancelled the insurance. It is called yield change indicator. If r_{t-1} is unknown (for example, because then the insurance was not in-force yet), the change in yield is defined with the $r_{t+1} - r_t$ formula. *Table 1* shows the distribution of the claims incurred according to the level of the change in yield defined above.

Table 1
Distribution of single premium surrenders according to the yield change indicator

	As a percentage of all surrenders	
Yield change indicator	**By policy**	**By premium**
–1% and below	12.6%	41.1%
Between –1% and 0%	7.3%	5.0%
0%	68.0%	47.6%
Above 0% (yield increase)	12.2%	6.3%

Source: Compiled on the basis of insurer data

In terms of the number of lapses, in the month following the lapse the interest rate level of the contracts would not have declined in the case of 80 per cent of the number of surrenders. Accordingly, we may assume that the lapse was not triggered by the internal interest rate level.

However, it is very conspicuous that 12.6 per cent of the number of surrenders shows a ratio of more than 40 per cent in the case of the distribution according to premium; moreover, this applies in the case when the yield change indicator was at the level of –1 per cent or below. It means that the other group of policyholders is expressly interest rate sensitive, and cancelled their contracts when the decline in interest rate reached 1 per cent (in absolute terms).

In order to better understand this effect, we classify the lapse events with the help of the *k*-means clustering known from multivariate statistical modelling and draw conclusions for the portfolio based on this, which finally allows us to group policyholders in terms of yield sensitivity with the help of contract parameters. At the individual level, we examine only this internal interest rate dependence. We do not have information whether in a case when a policyholder lapsed (cancelled his/her contract) he/she invested his/her money in a competing (higher-yield) investment product or terminated the insurance due to other reasons. However, as we will see, the yield change indicator is very informative with regard to lapses.

In the case of the clustering, all of the lapse events of the 3 years under review were observed, and the following variables were examined:

- the time that elapsed between the beginning and the lapse of the contract (months)
- the premium invested

- yield after the decision to cancel
- yield before the decision to cancel
- yield change indicator (difference of the previous two amounts)

The variables were standardised (transformed to have 0 expected value and a unit of standard deviation), so that the different units of measure and magnitudes should not distort the distances. The essence of *k*-means clustering is that the method should formulate *k* pieces of cluster centres in the space constituted by the selected variables, and then, classifying the individual observations on the basis of a defined distance to the nearest cluster centre, it should be possible to classify the observations into class *k*. It is possible to draw conclusions about the characteristics of the given group on the basis of the co-ordinates of the cluster centres. We do not present the further mathematical bases of the method; for more details see, for example, the work of *Kovács* (*2011*).

Clustering was performed with the help of the IBM-SPSS software. We examined the *k = 2, 3, 4, 5* cases. All of the variables involved had significant grouping power. In the *k = 2* case, based on the co-ordinates of the cluster centres, the following two clusters take shape (hereinafter they are called lapse clusters):

- Lapse cluster 1: low-premium, less yield sensitive policyholders in terms of lapse (upon lapse the yield declined to a lesser degree from a low yield level), and the time that elapsed from the start of the contract until the lapse was longer,

- Lapse cluster 2: higher-premium, more yield sensitive policyholders in terms of lapse (upon lapse the yield declined to a greater degree from a higher yield level), and the time that elapsed from the start of the contract until the lapse was shorter.

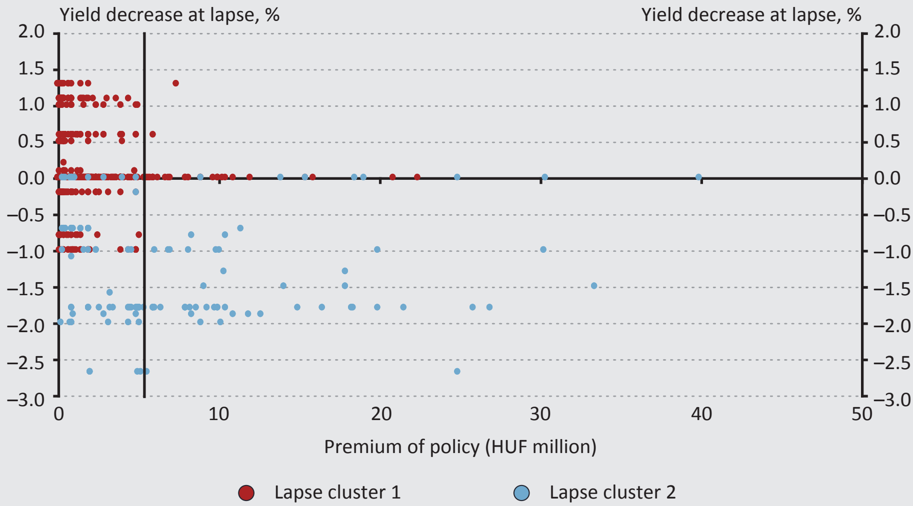
In the *k = 3, 4, 5* cases, the method decomposed the groups further mainly according to premium compared to the *k = 2* case; there were no major differences in terms of the time of the lapse and the yield indicators in the newer groups. Based on the so-called cluster elbow method coming into being on the basis of the ANOVA tables, the *k = 4* could also be an optimal choice, but in the case of the variances between the groups as well it is mainly the variance explained from the premium that grows with the increasing of the number of clusters. Therefore, we stay with the 2-cluster classification, with the interpretation as explained.

As we would like to classify the whole set of contracts (i.e. not only the lapsed contracts), and as the lapse data are not known in advance, of the variables under review, it is the size of the premium paid (which is known for each contract from the start of the contract) with which we attempt to approximate as best as possible the groups resulting from the lapse clustering. We achieve this by taking the co-ordinates of the cluster centres concerning the premium invested, and for each contract we examine to which point the premium of the given contract is closer.

Accordingly, the trim point coming into being will be the average of the two values (of the premium co-ordinates of the cluster centres). This type of group breakdown is hereinafter called clustering according to premium.

Figure 4 shows on a smaller sample of the data in the cross section of the size of the premium and the yield change indicator how the clusters according to lapse are positioned compared to the clustering according to premium (the latter is the left and right sides of the vertical line, where higher-premium policyholders, whose probability of lapse is typically higher, are located on the right side). The clusters according to lapse reflect the described characteristics well; significant differences are seen between the two groups both in the yield change indicator and the premium.

Figure 4
Clusters according to lapse and premium by dimensions of the premium size (HUF) and the yield change indicator



Source: Compiled on the basis of insurer data using results of IBM-SPSS software

We compared the contract classification resulting from the clustering by lapse and the clustering by premium with a crosstab in relation to all the lapse events (see *Table 2*). With the simpler classification by premium, 88.7 per cent of the multivariate clusters according to lapse can be explained. Breaking further down, 94.3 per cent of Lapse cluster 1 can be properly classified with the trimming according to premium class, while in the case of Lapse cluster 2 classification only on the basis of the premium is possible with a precision of 56.3 per cent.

As on the whole a good hit rate can be achieved with the classification according to premium as well for the groups of the lapse clustering, and in the following we analyse the complete set of contracts (not only the lapsed ones), we continue the analyses on the basis of the clustering according to premium.

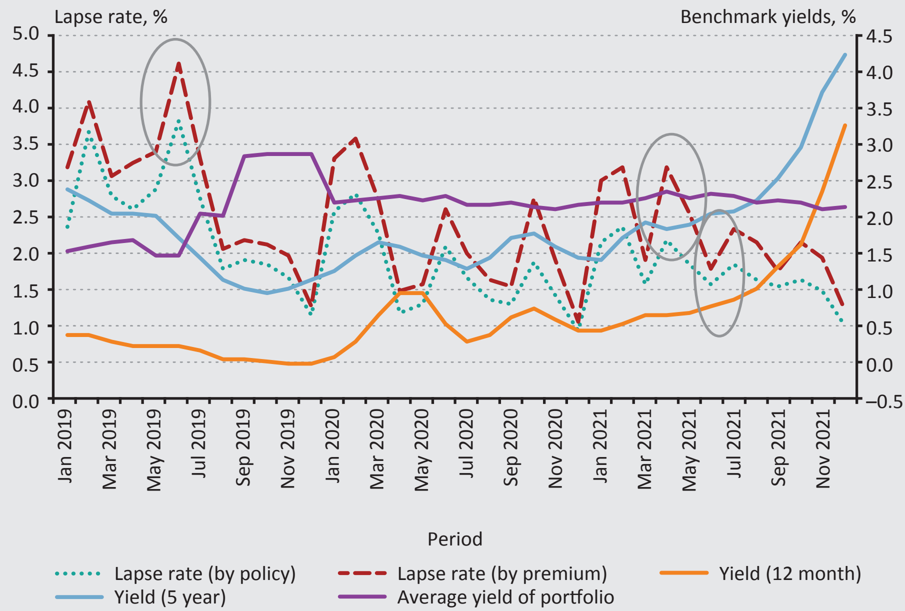
Table 2
Cross table comparison of clusters according to lapse and premium

Distribution of the groups as a percentage of all lapsed contracts		Lapse clusters		
		1	2	Total
Clusters according to premium	1	80.3%	6.5%	86.8%
	2	4.8%	8.4%	13.2%
Proper classification on the basis of clusters according to premium		94.3%	56.3%	88.7%

Source: Compiled on the basis of insurer data

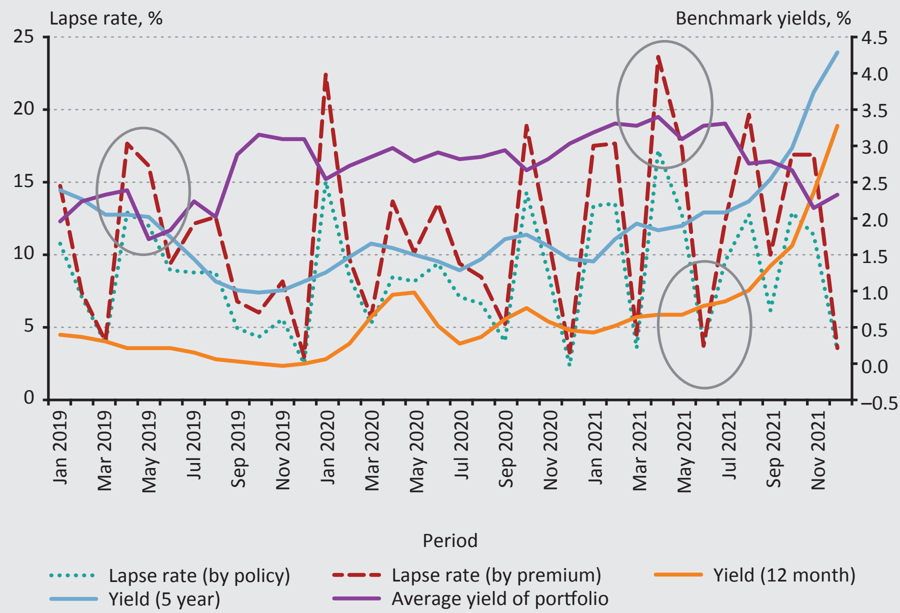
We divide the portfolio into two and draw the time series of the lapse rates according to the trimming resulting from the clustering according to premium (*Figures 5* and *6*), trusting that this allows us to see the lapse data already for more homogeneous groups. The time series of the lapse rates by policy and by premium come much closer to each other in the figures broken down to premium groups. Even in these figures the lapse rate by premium is somewhat higher, suggesting that even within these classes it is true that higher premiums entail a higher probability of lapse.

Figure 5
Lapse rates of single premium insurances (lower premium class) according to yields



Source: Compiled on the basis of insurer data and benchmark yields of the ÁKK

Figure 6
Lapse rates of single premium insurances (higher premium class) according to yields



Source: Compiled on the basis of insurer data and benchmark yields of the ÁKK

In order to better understand the volatility seen in monthly data, we continue to examine the set, which is now already broken down into two groups, to see whether the fluctuation may have any relation to the yields. We examine three periods in more detail (these periods are marked in *Figures 5* and *6*) to see what may cause the higher or lower lapse rates. We selected the following three periods:

- June 2019: The MÁP+ government bond was introduced in this month. It has offered extraordinary yield compared to (then existing) government bonds yields and other forms of investment, and has advantageous features both in terms of liquidity and tax conditions. Both figures show that high lapse rates were typical in this period.
- April 2021: Extremely high lapse rates were typical of both groups (but especially in the case of the higher premium class).
- June 2021: Both groups were characterised by low lapse rates.

Table 3
Monthly lapse rates of the two contract groups in three selected periods

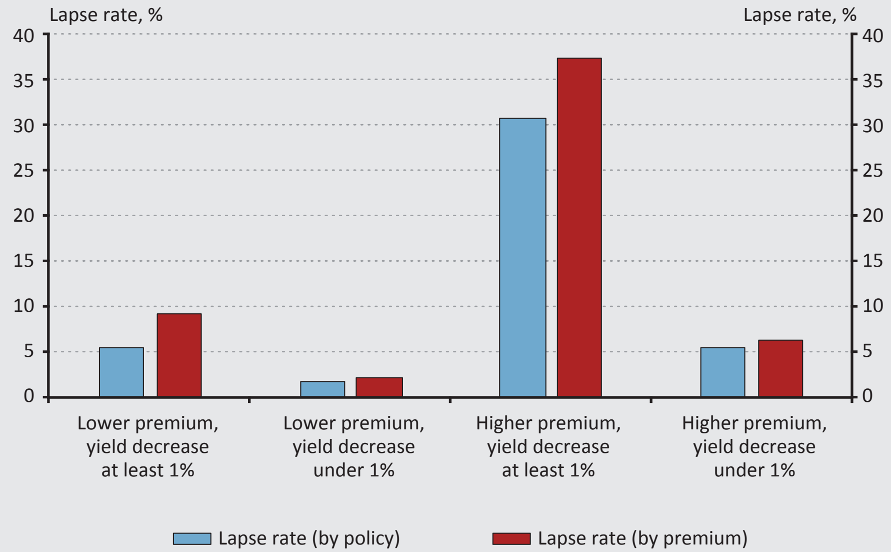
	June 2019	April 2021	June 2021	3-year lapse rate average
Lower-premium contract group				
Lapse rate by policy	3.81%	2.18%	1.56%	2.00%
Lapse rate by premium	4.60%	3.17%	1.78%	2.45%
Higher-premium contract group				
Lapse rate by policy	8.87%	17.09%	3.85%	8.55%
Lapse rate by premium	9.26%	23.46%	3.71%	11.47%

Source: Compiled on the basis of insurer data

In all of the three selected periods, we examined the yield change indicator in the case of the contracts of the two groups for both the complete sample and the contracts cancelled in the given month, and how the lapse rate changed compared to the average lapse rate (calculated over the 3-year period) typical of the group (*Table 3* and *Figure 7*, the diagram was presented only for the April 2021 data). *We recall that due to the limiting of business recognisability, the lapse rates are shown in a rescaled manner. However, the pattern between them was in line with what was seen in the case of the original data series as well.*

In June 2019, measured according to the previous definition, yields did not decline in any of the contract groups. Nevertheless, the lapse rate nearly doubled compared to the average in the case of the lower-premium group. Lapse was expressly high in the higher-premium group as well, although here the monthly data for the lapse rate by premium did not become higher compared to its own long-term average. We can come to the conclusion that the introduction of the MÁP+ government bond may have led to the high lapse rate. It is especially conspicuous how significant growth was entailed by the effect even in the case of the lower premium class (where yield sensitivity is typically lower). No correlation with the ÁKK benchmark yield was seen in the lapse rate, but a government scheme like the MÁP+ supported by good marketing and strong financial advantages resulted in a verifiable increase in lapse in the month of its introduction.

Figure 7
Lapse rates by premium class and yield change indicator (April 2021)



Source: Compiled on the basis of insurer data

In April 2021, it was clearly the yield change indicator that affected the lapse rate (*Figure 7*). In the lower premium class group, the lapse rate of the contracts for which the yield decline reached 1 per cent (in absolute terms) was 3–3.87 time higher (according to policy and premium) compared to the contracts for which the yield decline was less (or where there was a yield increase). The same indicator meant a lapse rate increase that was 5.8–5.9 times higher in the higher-premium group. From all of this, way can draw the conclusion that the internal yield level of the given product is a very strong indicator of lapse. A 1 per cent yield decline in absolute terms already encourages significant strata to surrender. It is even more typical in the case of the higher premium class (where the ratio of yield sensitive policyholders is even higher), but even in the lower premium class there were significantly more lapses before the possible yield decline taking place.

It can be detected in June 2021 as well that the probability of lapse was also higher for the contracts where the yield decline was greater. However, in this period the ratio of contracts exposed to yield decline was very low (the yield level remained unchanged or increased by the next month for more than 90 per cent of the portfolio). Consequently, the lapse rate was stagnant.

Finally, we carried out the Granger causality test for the two premium classes in order to learn whether the benchmark yield is a Granger cause of the lapse. In each case, the null hypothesis could be accepted at the usual significance levels that the

Granger causality relationship does not materialise. One of the possible reasons is that the benchmark yield was lower than the average yield of the portfolio for almost all of the period. It may be expedient to repeat this analysis as well in a year's time, if the benchmark yields remain persistently high until then as well.

From the analyses presented, we may conclude that the yield level is one of the main factors of lapse in the case of the single premium insurance under review, as in the months when a major change took place in the external or internal yield levels, the lapse rate also increased, and low lapse was typical when there was no such event. However, in terms of the external yield level, no relationship with the benchmark yield could be verified, but in the month of the introduction of the MÁP+ we detected a significant increase in lapse. Policyholders are sensitive to the changes in internal yield level as well. In this regard, we identified a difference in lapse according to the insurance premium; the ratio of those who are yield sensitive is higher among the higher-premium policyholders, but lapse driven by changes in the yield level was observed in the lower premium class as well.

4. Effects of changes in the inflation environment on lapses of the life insurances under review

In this section, we examine the relationship between lapse rates and inflation. We depict the seasonally adjusted core inflation[7] published by the MNB in one figure with the lapse rates and the level of the technical interest rate, and in the case of the single premium insurance with the average interest rate level of the short-term yield periods. The analysis is mainly motivated by the rise in the level of inflation from 2021 H2: we were interested whether its impact on the lapse rates can be detected. *Balogh* (*2021*) presents the possible underlying reasons of the increase in inflation in 2021.

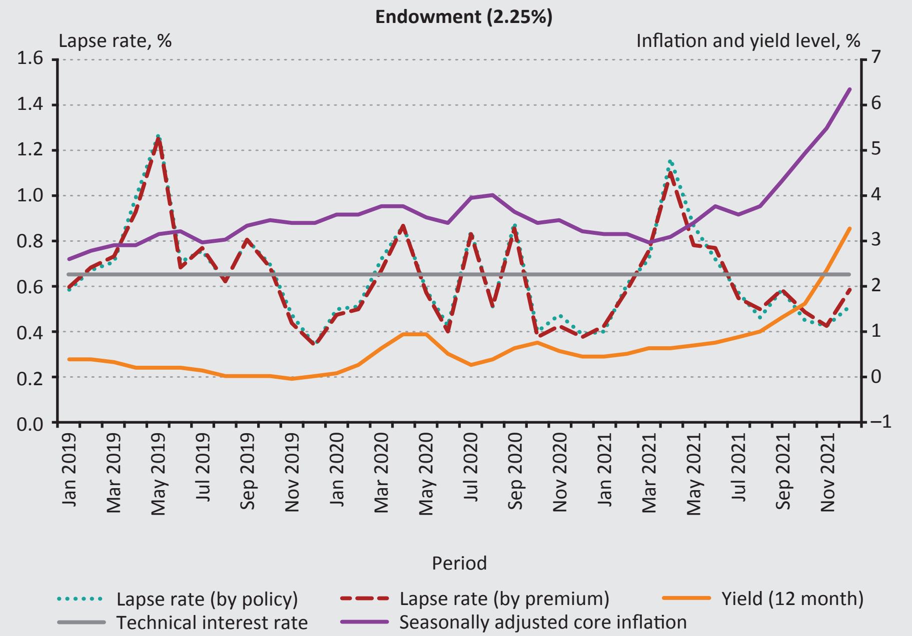
As similar trends are seen in the other cases as well, we illustrate only the figure of the contracts of the endowment product and of the single premium insurance belonging to the lower premium class. The conclusion to be drawn on the basis of *Figures 8* and *9* is that the lapse rates did not increase with the rise in inflation.

We attempted the testing of the Granger causality relationship here as well, but even the second difference of the inflation rate could not be considered stationary. Nevertheless, a relationship between the 12-month benchmark yield and the inflation rate is seen on the basis of *Figure 8*. If two time series have a common long-term path on which they move together, the two time series are called cointegrated. Carrying out the Engle–Granger test (see, for example, *Kirchgässner et al. 2013*)

[7] See: https://www.mnb.hu/statisztika/statisztikai-adatok-informaciok/adatok-idosorok/vi-arak Downloaded: 15 February 2022. Since then: https://statisztika.mnb.hu/idosor-1479

in Gretl, the two time series can be considered cointegrated.[8] As we managed to detect that inflation and the benchmark yield move on one path, and we previously realised that the benchmark yield did not affect the lapse rate in the case of the insurances under review, we can assume the same in relation to the inflation as well.

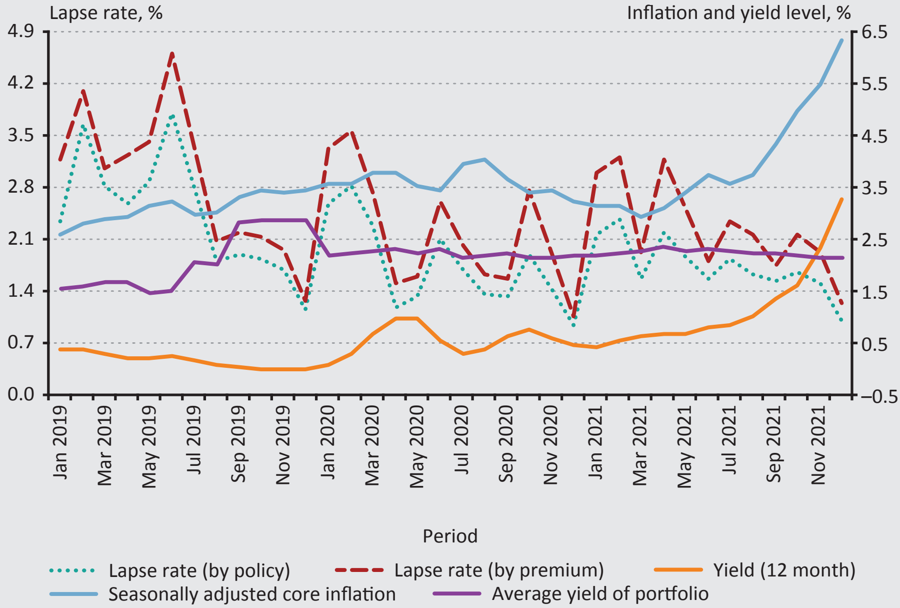
Figure 8
Lapse rates of endowment product according to inflation



Source: Compiled on the basis of insurer data and the MNB's inflation rate

[8] Of course, here we must not forget that the central bank started an interest rate hike strategy in order to ease the inflationary pressure, and the correlation and the verifiable cointegration may result from that as well. Whether the cointegration would exist under other circumstances as well is not important in respect of the study, and we do not examine it. For the various models of interest rate theories and certain empirical results of the correlation between interest rates and inflation see, for example, the study by *Ábel et al.* (*2019*).

Figure 9
Lapse rates of single premium insurances (lower premium class) according to inflation



Source: Compiled on the basis of insurer data and the MNB's inflation rate

It is also conspicuous that the interest rate level inherent in the insurances did not reach the inflation rate in the period under review, but apart from the last half year the internal interest rate level was almost always higher than the current 1-year and 5-year benchmark yields (see, for example, *Figures 5*, *8* and *9*). Accordingly, even with government bonds having these maturities, it would not have been possible to attain a higher yield than the internal yield level or inflation. Both the benchmark yield and inflation started to increase and departed more significantly from the internal interest rate level of the portfolios in 2021 H2. For the time being, no increase in the lapse rates was observed in this period, but here as well it may be expedient to repeat the analysis at a later time in order to find out whether the frequency of surrenders appears as a lagged effect.

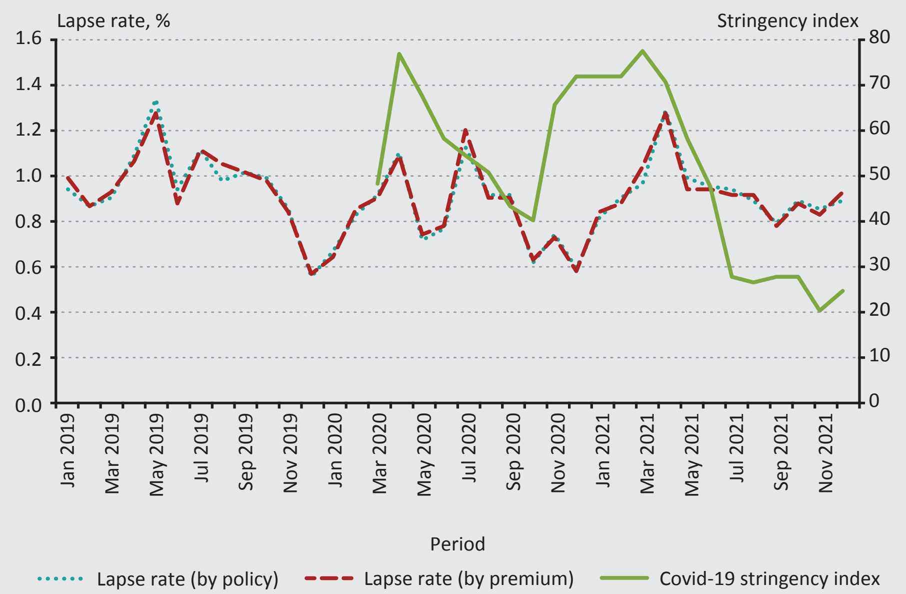
5. Impact of the stringency index related to the Covid-19 lockdowns on lapses of life insurances

The degree of the restrictions related to Covid-19 is measured with the stringency index, as noted above.

Due to space limitations, only two figures are shown here as well: they concern the endowment product and the lower premium class of the single premium insurance. We assumed that the possible lockdown effect due to Covid-19 does not become differentiated according to the technical interest rate, and therefore here in the case of the endowment product we did not screen the data according to the technical interest rate, but the portfolio belonging to all interest rates is included as a whole.

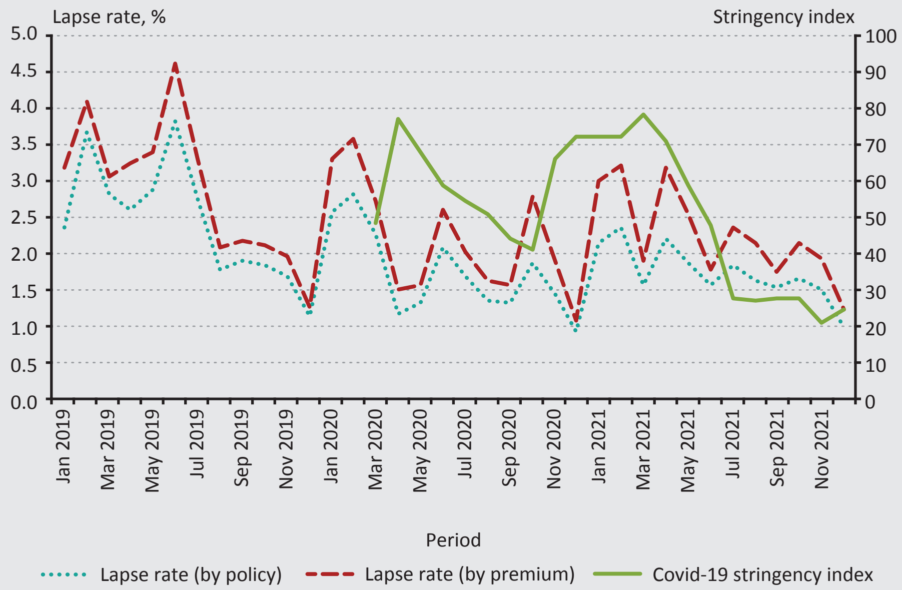
The lockdowns due to Covid-19 did not have any major impact (measured with the stringency index) either on the lapse rates of current premium or single premium life insurances. It can be seen in *Figures 10* and *11* that in the period following the outbreak of the pandemic the lapse rate practically did not leave the band observed in the period between January 2019 and February 2020 in any direction.

Figure 10
Lapse rate of the endowment product according to the Covid-19 stringency index



Source: Compiled on the basis of insurer data and the stringency index

Figure 11
Lapse rates of the single premium insurance according to the Covid-19 stringency index



Source: Compiled on the basis of insurer data and the stringency index

It is interesting, however, that in the case of the current premium insurance there seems to be some relationship: lapse rates increased to some extent with a lag of some months after the major lockdowns. Logically, the underlying reason for this lag may be that policyholders draw on these long-term savings only if it is necessary in any case and they do not have any other liquid sources. Also, the insurance company applies a grace period of some months if the premium is not received, so this may be another cause of the lag.

Again with the help of the Granger causality, we examined whether the aforementioned effect can really be proven statistically as well. For this, we kept the parts of the time series starting from March 2020 in relation to the beginning of the pandemic, which resulted in relatively short time series. We could consider the time series stationary after the second differentiation; they were the ones we worked with. The hypothesis that the Covid-19 stringency index is not a Granger cause of the lapse rate could be accepted at all usual significance levels, in the case of all types of insurances. Of course, it cannot be ruled out that some kind of more complex economic dependency amended the path of lapses, but on the basis of the short time series and the little data available we could not find evidence for that. In addition, a convincing argument for the assumption that even if there was such an effect, it was not significant is that according to the figures the lapse rates did not move out of the previously typical band either upwards or downwards during the pandemic.

6. Summary and final conclusions

In the study, we examined the relationship between the lapse rate time series of various life insurances and the yield environment. There was no relationship between the lapses of regular premium insurances with a technical interest rate and the benchmark yield. In most of the period and the portfolios under review, the technical interest rate exceeded the relevant benchmark yields, but the lapse rate did not increase even when the benchmark yield exceeded the technical interest rate. In the case of the single premium insurances, especially those policyholders' yield sensitivity is greater that have higher savings. According to the analyses, lapse rates may already rise significantly (even 6 times higher) in the case of an at least 1 percentage point yield decline. A significant effect may also prompt policyholders with lower savings to cancel, but there the ratio of the yield sensitive clientele is lower. However, a government bond supported by good marketing and strong financial advantages (such as the MÁP+) may make a higher number of policyholders in the latter group also cancel their insurances and invest their savings in competing products (although we do not have information on the second part of the assertion, i.e. that policyholders really invested their money following the lapse; we can only assume that). The rise in inflation has not increased the lapse rate yet. However, just as in the case of the rising yield curve, not much time has elapsed here either since the change in the macro environment; circumstances may still change as time goes by.

We may assume on the basis of the above that financial literacy and awareness are not yet developed enough in Hungary for the social stratum that has savings to be completely informed about the current interest rate, investment and inflation environment, enabling everybody to make optimal investment decisions in line with the given situation. The clientele with higher amounts of savings is more informed, dependence on the (internal) interest rate environment was more verifiable there, but – to a lesser degree – this effect was present in the lower-premium group as well. We can assume that the social group under review needs a well understandable and easily accessible investment product (e.g. the insurance company's single premium product under review, MÁP+ government bond, etc.), and individuals make their investment decisions in accordance with these known dimensions and current conditions. The above conclusions were true for the group of policyholders with single premium insurances; in their case the changes in yield level played a more important role. Long-term savings, life insurance coverage or the tax refund possibility of the pension product are the likely reasons for concluding the contracts in the case of regular premium insurances; here the lapse rate did not depend on the current yield and inflation levels.

Of course, the analysis is not representative for the country as a whole (other strata were not examined, but presumably there are many people who are even less conscious – for example those who keep their savings in cash or on a bank account; and presumably there is also a stratum that is more conscious than the ones presented here). We can surely state that a life insurance company which sells mass products and has a large portfolio shows relevant experiences about a significant stratum.

The lockdowns due to Covid-19 did not have any major impact on the lapse rates of life insurances in any insurance type. In the case of the examples under review, even in the period of the pandemic the lapse rate did not leave the band typical before – neither upwards, nor downwards. For regular premium insurances, a slight increase in lapses with a lag of some months was observed, but this effect was not strong (statistically not significant). This also suggests that policyholders invest in these products with the aim of long-term savings, and even during the lockdowns due to Covid-19 no major stratum of the clientele got into such a bad financial situation that would have increased the lapse rates drastically. There was also no direct relationship in the case of the single premium insurance either and the previously described effects tend to dominate there.

It may be a reason for optimism that, as we know at present, the effect of the pandemic on the functioning of the country is waning, and hopefully the economy and the insurance sector will return to the pre-pandemic operation. Changes in the yield and inflation environments may still affect developments in the life insurance market in the longer run. It could be expedient to examine the related effects later as well and to adjust insurance companies' long-term strategies to the consolidating circumstances.

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