INTEREST RATES AND HOUSEHOLD SAVING BEHAVIOUR: AN EMPIRICAL PUZZLE AND A SOLUTION USING CZECH DATA[*]

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Abstract

This paper investigates the transmission from interest rates to household saving behaviour when introducing two main innovations of analysing this relationship. The first one is based on the use of a set of client interest rates instead of one monetary policy rate. This step enables us to distinguish impacts of the substitution and income effects in more detail. The second major innovation lies in the division of households into income categories, which provides us with more observations and thus makes it possible to conduct this analysis even for a single country. Using the generalized method of moments for the dynamic panel data, we analyse Czech household behaviour for the period 2004–2015. The results highlight that when we ignore details of the transmission channel and use only a monetary policy rate, we lose crucial information about contradictory impacts of the substitution and income effects that are primarily reflected in the client interest rates. This fact may clarify most of the interest rate–savings rate puzzle.

Keywords: Client interest rates, monetary policy rate, savings rate, income categories, Czech households, panel GMM
JEL Classification: C33**,** D12, D14

1. Introduction

The transmission from interest rates to household saving behaviour is the crucial issue when implementing a monetary policy. However, even after decades of empirical research, the true nature of this relationship does not seem to be entirely clear. For the sake of monetary policy recommendations, most of this research focuses on the transmission from the monetary policy rate to households while not bothering to deeply investigate

the transmission channel itself. This approach usually leads to ambiguous and contradictory results and only serves as a source of dispute about the very influence of interest rate. However, the true essence of this empirical puzzle does not have to lie in the very nature of the relationship, but rather in the way of looking at it.

The causal relationship between the interest rate and the savings rate is, at first glance, quite logical and relatively intuitive. A higher interest rate promising greater appreciation motivates households to save more. Then we should observe a proportional relationship between the interest rate and the propensity to save. Is this simple premise, however, in line with reality? Perhaps we should first ask whether this assumption is fully consistent with the current state of theoretical knowledge. The theory of intertemporal substitution in consumption has already shown that reality is not as simple as this. As with microeconomic analysis, we need to distinguish between the influence of the substitution effect and the income effect. In terms of current consumption, the interest rate actually reflects the opportunity costs. Together with the growth of potential money appreciation, consumption becomes relatively more expensive; on the contrary, making savings becomes more advantageous. So when the interest rate rises, households are motivated to replace their current consumption expenditures with savings. Thus, the substitution effect positively affects the savings rate. Conversely, the income effect implies that a higher interest translates to a higher expected income and therefore higher consumption both in future and at present. The observed impact is therefore negative. In other words, the substitution effect says that a higher interest rate will make saving more attractive but also less necessary due to the income effect.

It is clear that these two effects work against each other and the resulting impact on the saving behaviour, when considering only the monetary policy rate, is then controversial, unstable and probably depends on many other factors, as confirmed by the empirical research to date (see the following chapter). As a result, we can discuss a type of empirical puzzle here. However, the true essence of this puzzle (and its solution) does not necessarily lie in the unclear nature of the relationship itself, but rather in the way in which we examine it.

The main goal of this study is to shed a little light on this empirical puzzle by introducing a new method of investigating the interest rate–savings rate relationship. There are two main innovations within this new approach. The first one is based on the use of a set of client interest rates instead of one monetary policy rate. This step enables us to distinguish impacts of the substitution and income effects in more detail. The second major innovation consists in the division of households into income categories, which provides us with more observations and thus makes it possible to conduct this analysis even for a single country. This approach can potentially open a new way of analysing the interest rate pass-through in terms of household behaviour.

To achieve this goal, we make an econometric analysis of dynamic panel data. Using the generalized method of moments and the fixed effects modelling, we analyse Czech household behaviour for the period 2004-2015. Our dataset is mainly based on annual data from the Czech Statistical Office and the database of the Czech National Bank.

The structure of the paper is as follows. The second section represents a review of the empirical literature. In Section 3, we introduce the methodology, followed by the description of the dataset and the model in Section 4. Section 5 puts forward the results and the related discussion. Section 6 concludes.

2. Literature Review

What does the empirical research reveal about the influence of the interest rate on the savings rate? Is this relationship really significant? If so, does the substitution effect prevail and can we also expect the propensity to save to increase with a rise in the interest rate? Or does the negative income effect dominate? A number of studies and empirical tests using the monetary policy rate have already been carried out with the motivation to solve these questions, although the answers still remain ambiguous.

According to simple logic, superiority of the substitution effect, which is usually more visible at first glance, could commonly be expected. However, as shown by recent experience with the global economic crisis, accompanied by a sharp rise in savings rates at falling interest rates, the reality may also be the reverse. This fact is also confirmed by Mody *et al.* (2012) in their panel study for advanced economies. They also show that the primary source of the surge in saving trends was the newly generated uncertainty and therefore the precautionary saving effect. It might seem that the interest rate alone is not the primary determinant of a propensity to save or to consume. These doubts, however, were disproved by Loayza *et al.* (2000) long before the crisis. With a wider range of countries and over a much longer period of time, they showed that the income effect unequivocally prevails over the substitution effect and is thus a significant source of variability for the observed savings rate.

Evidence of the predominance of the substitution effect (on an international dataset) is provided, for example, by Masson *et al.* (1998). Especially for a sample of advanced economies, they identify the less robust, yet positive, nature of the desirable relationship. The same conclusion was later made by Hondroyiannis (2006) for the European set of countries. However, the recent work of Aizenman *et al.* (2016) best describes the confusion and ambiguity of the empirical results in this area. Although the authors primarily confirm the predominance of a positive effect between the trends in the interest rate and propensity to save, they still point out that, at very low interest rate levels, the effect may also be the opposite. In accordance with the work of Mody *et al.* (2012),

they draw attention to the link between low interest rates and a precautionary motive in generating financial reserves.

As we can see, the empirical results using the monetary policy rate are very contradictory. Where one study reveals a positive impact of the interest rate on the propensity to save, another study will eventually make the opposite claim. The particular form of observed dependence is in all likelihood not a matter of general validity, but it is very sensitive to the specific characteristics of the given economy, time and, of course, the settings of the model used. The only thing that most studies agree on is that if the influence of the monetary policy interest rate on the ratio in which the disposable income is distributed between saving and consumption can be proven, then this effect is rather weak, not very robust, and therefore not quite stable.

3. Methodology

When conducting empirical analysis, the relationship between the monetary policy rate and the household savings rate seems to be unclear or not strongly significant. However, it does not have to mean that changes in the central bank rates have no influence on household behaviour. It is necessary to keep in mind that the substitution and income effects work against each other so that the resulting effect may often be ambiguous. However, it does not mean that their separate influences are ambiguous and weak in the same way. On the contrary, they may be clear and strongly significant, while also being hidden in the transmission from the monetary policy rate to households. Identifying those effects, *i.e.*, distinguishing between the income effect and the substitution effect in more detail, is the primary goal of the following analysis.

In order to achieve this goal, our analysis must differ significantly from classical approaches investigating the interest rate–savings rate relationship (see the previous chapter). In particular, we have made the two following innovations.

We do not use a single monetary interest rate; instead, we utilise multiple types of client interest rates together. What is the reason for this change? Firstly, there is a clear logic in this. If we want to distinguish between the income effect and the substitution effect in the interest rate transmission in more detail, we need a more detailed division of interest rates. In other words, we do not have to rely on a single variable; instead, we can use a wide range of client rates that themselves can work differently. Both the income effect and the substitution effect can, of course, prevail in interest rates on both deposits and loans. Another advantage of this procedure may be the simple premise that when examining the determinants of the household savings rate, it is far more appropriate for its analysis to use the variables which the households actually come into contact with. In other words,

if a study finds a significant causal relationship between the monetary policy rate and the propensity to save, it must necessarily be a secondary or mediated relationship. It is not possible for households to be directly affected by a type of interest rate they will never come into contact with. If we want to dive into the very essence of the problem and examine the primary influence of these two variables, it is necessary to use the interest rate at which households can actually borrow or save, that is a client interest rate.

The second major change is that we do not examine the impact of interest rates on a single aggregate savings rate, but rather on the propensities to save of individual income categories. First of all, this step (resulting in panel data modelling) provides us with many more observations and thus it enables us to conduct this analysis even for a single country. Moreover, unlike many other studies, we will be able to take into account the heterogeneity with which the different income groups react on basic determinants of their budgetary decision making.

3.1 Methods of estimation

As has been evident since the random walk model (Hall, 1978), the best estimate of consumption or savings at the time $t + 1$ is commonly its value at the time t. Therefore, as has been demonstrated by countless empirical studies, it is possible to achieve a considerably higher explanatory ability of the model by including the lagged dependent variable among the regressors. However, using the fixed effects approach to estimate a dynamic panel data model would not be able to ensure the exogeneity for all regressors. The endogeneity of a lagged dependent variable is always given by definition and so it cannot be removed by using a within estimator. Therefore, this variable must be instrumented. As part of the further analysis, we use a general approach to the estimation of the dynamic panel data model developed by Arellano and Bond (1991), *i.e.*, the first-difference generalized method of moments (FD-GMM) with the coefficient estimator for the given x variable:

$$\hat{\beta} = \left[\left(\Delta x_{-1} \right)' W \left(W' \left(I_N \otimes G \right) W \right)^{-1} W' \left(\Delta x_{-1} \right) \right]^{-1} \times$$

$$\times \left[\left(\Delta x_{-1} \right)' W \left(W' \left(I_N \otimes G \right) W \right)^{-1} W' \left(\Delta x \right) \right], \tag{1}$$

where W stands for the matrix of instruments of lagged levels of x given by the matrix G, which by definition is given by $T - 2 \times T - 2$. We also use a similar approach later derived by Arellano and Bover (1995) and Blundell and Bond (1998), *i.e.*, the system generalized method of moments (SYS-GMM), which provides other additional instruments using the estimator for the given x variable:

$$\hat{\eta} = \left[\sum_i (W_i \otimes m_i)' \left(\hat{\Omega} \otimes \sum_i m_i m'_i \right)^{-1} \sum_i (W_i \otimes m_i) \right]^{-1} \sum_i (W_i \otimes m_i)'$$

$$\times \left(\hat{\Omega} \otimes \sum_i m_i m'_i \right)^{-1} \sum_i (y_i \otimes m_i), \tag{2}$$

where Ω is a covariance matrix, m_i represents the subset of explanatory variables uncorrelated with random error and stands as the last element of the diagonal matrix of instruments W_i, which is now given by moment conditions in both levels and differences[1].

For the purpose of a robustness check and possible comparison of results, we use both FD-GMM and SYS-GMM. Since it is very difficult in practice to find out whether the regressor is correlated with the present or past values of random error, only the variable representing the average age of the population is assumed to be strictly exogenous and all the other variables are first treated as endogenous and the model is estimated once again while assuming those variables as predetermined.

4. Data Analysis

We test the causal relationship of interest rates and savings rates using a dataset for the Czech Republic. The main source of the data is the Czech Statistical Office, while information about income categories has been taken from the Household Budget Survey (HBS). The values of client interest rates have been obtained from the database of the Czech National Bank, and the values of the PX index from the Prague Stock Exchange. Due to the annual nature of the HBS, we had to recalculate all other data into annual averages for the period 2004–2015[2].

As mentioned above, we investigate the saving behaviour of income categories. They are presented by sub-aggregation of HBS data into ten same-sized categories in ascending order according to net income. The default time series for those income deciles includes average consumption and net income per capita expressed nominally[3] in CZK. These variables are used to calculate the average propensity to save (APS) as a simple share of savings on the net income.

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1   For a more detailed description, see Baltagi (2013).

2   The time period that we use is strictly limited by the data methodology. The client rates that we use were not statistically observed by the Czech National Bank before 2004. Since 2016, the Czech Statistical Office has replaced the quota assignment by random assignment in the HSB methodology.

3   Although we are generally interested in the economic behaviour in the real terms, due to the relative nature of the variables *APS* and *YR*, the effect of changes in the price level is completely eliminated. In other words, there is no sense in talking about real or nominal *APS* or *YR*.

The evolution of APS in time is shown in Figure 1. Firstly, as could be generally expected, there is a significant variance in the APS across income deciles for each year, since richer households on average are able to save a larger fraction of their income. Secondly, following the mean value of APS in time (APS_mean), we can identify a slightly positive trend, especially after the crisis. This finding is fully in line with the precautionary saving behaviour of households and, in times of decreasing interest rates, it also indicates the predominance of the negative income effect. However, without controlling for other factors influencing the savings rate, this finding may only be a preliminary visual assumption that is going to be tested in the subsequent regression analysis.

Figure 1: Evolution of APS in time
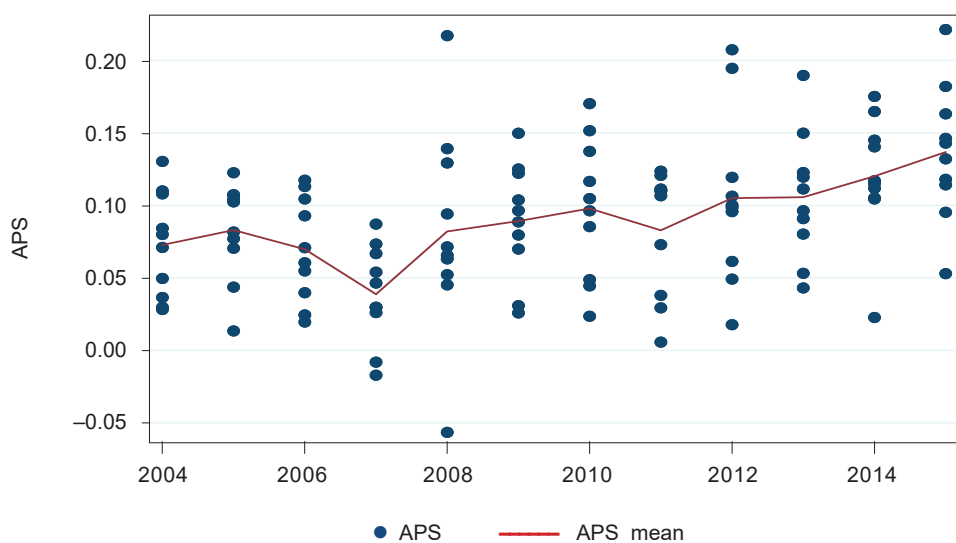
Source: Own calculations and processing in Stata 15.

The main explanatory variable – the relative income in the sense of a relative income hypothesis (Duesenberry, 1949; Frank, 1985; Clark *et al.*, 2008) was derived according to the methodology of Badura (2018):

$$YR_{i,t} = \frac{Y_{i,t}}{\overline{Y}_t} \; ,$$ (3)

where the relative (net) income of the category i at the time t ($YR_{i,t}$) is calculated as the share of the net income of the same category $Y_{i,t}$ on its reference value $\overline{Y}_{i,t}$, which is given as the weighted average of net incomes of all the income categories at the given time, in particular by the pattern:

$$\overline{Y}_t = \frac{\sum_{i=1}^{N} Y_{i,t} w_{i,t}}{\sum_{i=1}^{N} w_{i,t}} \tag{4}$$

where weights ($w_{i,t}$) are set as the average numbers of household members in a given category and where N is the number of those categories (ten in our case).

The full dataset that we use in the following analysis includes:

APS – average propensity to save,
YR – relative (net) income,
inf – inflation rate as an increase in average annual CPI,
u – general unemployment rate,
age – average age of the population,
ratio – ratio of old-age pension to average wage,
estate – year-over-year growth of the house price index[4] (including houses, apartments, apartment buildings and building plots),
PX – official price index of the Prague Stock Exchange,
balance – share of general government balance to nominal GDP,
i_1 – nominal[5] interest rate on overnight deposits,
i_2 – nominal interest rate on deposits redeemable at notice,
i_3 – nominal interest rate on consumer credit,
i_4 – nominal interest rate on mortgages,
i_5 – nominal interest rate on overdraft loans,
i_6 – nominal interest rate on credit card receivables.

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4 For a detailed analysis of the influence of house prices on consumption and savings rates of Czech households, see Brůha *et al.* (2017).

5 As can be seen, nominal rates are used in all the cases, although according to economic logic, primarily the real interest rate should have an influence on household budgetary behaviour. However, we do not lose any information in this case as the inflation rate is also included as a separate indicator. On the contrary, by an elementary decomposition of the real interest rate, we can easily separate the influence of nominal variables and movements in the price level. Households can no doubt identify these separate indicators much better than the resulting real interest rate.

4.1 Model

As described above, to achieve a higher explanatory ability of the model, we also include the lagged dependent variable among the regressors, resulting in a dynamic panel data model. If we also want to control for the fixed influence of individual entities, the default model M1 for the estimation of the short-run savings rate of Czech income categories takes the following form:

$$APS_{i,t} = \beta_0 \cdot APS_{i,t-1} + \beta_1 \cdot X_t + \beta_2 \cdot Z_{i,t} + \gamma + \mu_i + \varepsilon_{i,t}, \qquad (5)$$

where the average propensity to save (savings rate) $APS_{i,t}$ of the income category i at the time t is estimated using its lagged value $APS_{i,t-1}$, the vector of variables of our interest (client interest rates) X_t and the vector of control variables $Z_{i,t}$. The parameter β_0 is a scalar expressing the sensitivity of the average propensity to save to its lagged values, β_1 represents the vector of the estimated coefficients for the client interest rates and β_2 the vector of estimations for the controls. The symbol γ denotes the level constant, μ_i is the unobserved individual effect and $\varepsilon_{i,t}$ is then the remaining residual component.

The vector X_t is defined by the dimensions 6×1 and includes all the client interest rate variables. The vector $Z_{i,t}$ is 7×1 and includes the variables: *YR*, *inf*, *u*, *age*, *ratio*, *estate*, *PX*. For the purpose of a robustness check, we also introduce an alternative model M2, where the vector $Z_{i,t}$ additionally includes the variable *balance*. All the control variables were chosen on the basis of both the theoretical knowledge about the consumption-saving function, mainly from postulates of the life-cycle hypothesis (indicators *age*, *ratio*), and modern empirical works (see Section 2). To take into account the specific environment of the Czech Republic, we can draw on the detailed description of local consumption function by Artl *et al.* (2001), stress testing of Czech households by Malovaná *et al.* (2018) or the work of Brůha *et al.* (2017), analysing household responses to changes in house prices. At the same time, however, it was necessary to take into account the sub-aggregated nature of the data, especially by implementation of relative income as defined by Badura (2018).

The vectors of estimated parameters β_1 and β_2 take the dimensions 1×6 and 1×7 respectively in model M1. In model M2 they take the dimensions 1×6 and 1×8. Because both the substitution effect and the income effect can prevail in the interest rate–savings rate relationship (in the case of the interest rate on both deposits and loans), neither positive nor negative values of the coefficients of the vector β_1 can be assumed explicitly; they may even reach positive or negative values depending on the specific interest rate. Therefore, the signs of the wanted coefficients are by no means the premise of this analysis, but of its result, which will be discussed in the final chapter.

4.2 Data preparation

Before the model estimation, we need to check for two OLS assumptions (and also GMM assumptions) that would not be easy to solve during the estimation process: the existence of stationarity and no multicollinearity. We can then proceed to the very estimation of models M1 and M2.

Although the input time series are not especially long, it is useful to begin by checking for their stationarity. This was done using three tests based on the null hypothesis of the unit root existence: Harris and Tzavalis, Breitung and Im, Pesaran and Shin.[6] As the condition of stationarity in our dataset (due to the time series length) is not especially strict, we consider stationary only those variables for which the zero hypothesis was rejected by all the tests at the significance level of 0.1 at least. In this case, our requirements are met by the indicators: *APS*, *YR*, *inf*, *ratio*, *estate*, *PX balance*, i_3, i_6. The other variables were converted to differences (suffix "_d") in order to remove the unit root and tested again.

Our stationarity condition is then met by all the modified variables apart from i_2_d. It is worth noting that, when converting to the second difference, this variable finally fulfils the condition of stationarity, although this time at too high a cost. It is important to bear in mind that with each differentiation we lose N (number of entities) observations and, due to a smaller number of input time periods, another such loss for the sake of one variable is not acceptable. For this reason, the variable i_2 is completely discarded from both M1 and M2, while the indicators *age*, *u*, i_1, i_4, i_5 are replaced with their differences.

The next step in the data preparation procedure was to verify whether there is a significant multicollinearity among the independent variables. For this purpose, we use a matrix of Pearson correlation coefficient values. While it is worth keeping in mind at this point that there is no natural boundary separating multicollinearity from an acceptable correlation rate, a value of the correlation coefficient around 0.8 is very often considered to be the limit.[7] To ensure a more precise (unbiased by multicollinearity) explanatory ability of the vector β_1, we are going to be more strict and set the limit to 0.7. Following this rule, the control variables *inf*, *u_d*, *estate* and *PX* had to be removed from both M1 and M2 as they are highly correlated with client interest rates (which are essential for our analysis, and for this reason they had to stay). However, due to the high correlation with other regressors, most of the variability of the removed indicators still remains hidden within the highly correlated variables, and so we do not lose much information by this step.

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6   Results of the stationarity tests and the correlation matrix (next section) could not be displayed due to the limited length of the article. They can be obtained by contacting the author.

7   Although this method is rather a rule of thumb than an accurate evaluation of multicollinearity, for smaller sample sizes like this it can be considered sufficient.

5. Results and Discussion

The results for all the estimated model types are shown in Tables 1a and 1b. For the purpose of a robustness check, both models M1 and M2 are estimated using FD-GMM and SYS-GMM, assuming explanatory variables being endogenous (suffix "-e") and predetermined (suffix "-p"). In accordance with the work of Arellano and Bond (1991), a robust estimation of the standard error was used to ensure the homoscedasticity of the residuals. We must also note that all the variants of the estimated models pass the Sargan-Hansen test, which indicates the correct specification of the model due to the exogenous nature of all the instruments used.

Table 1a: Estimation results for model M1

	FD-GMM-e	FD-GMM-p	SYS-GMM-e	SYS-GMM-p
i_1_d	0.056 (0.036)	0.056 (0.037)	0.063 (0.039)	0.062 (0.038)
i_3	0.017*** (0.004)	0.017*** (0.004)	0.018*** (0.004)	0.017*** (0.004)
i_4_d	−0.015** (0.006)	−0.015** (0.006)	−0.015** (0.006)	−0.015** (0.006)
i_5_d	0.034*** (0.007)	0.034*** (0.007)	0.033*** (0.007)	0.033*** (0.007)
i_6	−0.03*** (0.005)	−0.03*** (0.005)	−0.029*** (0.006)	−0.029*** (0.006)

Table 1b: Estimation results for model M2

	FD-GMM-e	FD-GMM-p	SYS-GMM-e	SYS-GMM-p
i_1_d	0.057 (0.036)	0.056 (0.036)	0.064* (0.038)	0.062* (0.037)
i_3	0.016*** (0.004)	0.016*** (0.004)	0.017*** (0.005)	0.017*** (0.005)
i_4_d	−0.014 (0.009)	−0.014 (0.009)	−0.014 (0.009)	−0.014 (0.009)
i_5_d	0.034*** (0.008)	0.034*** (0.008)	0.033*** (0.008)	0.033*** (0.008)
i_6_d	−0.031*** (0.006)	−0.031*** (0.006)	−0.03*** (0.006)	−0.03*** (0.006)

Notes: The first number is the coefficient value. The number in the parentheses stands for the standard error. The symbols ***, **, * show the statistical significance at 1%, 5% and 10% respectively. The column title denotes the estimation method: FD-GMM stands for the first-difference generalized method of moments, SYS_GMM stands for the system generalized method of moments. The suffix "-e" means we assume all regressors except *age_d* being endogenous, the suffix "-p" means we assume all regressors except *age_d* being predetermined.

Source: Own calculations and processing in Stata 15.

Using the Arellano-Bond test we also fail to reject the null hypothesis of no second-order serial correlation for residual differences for any of the reflected models.[8]

First of all, it is important to emphasise that the estimates for all the client interest rates are extremely stable, their signs, magnitude and standard errors (except i_4_d) do not change significantly across all the types of models and methods. Therefore, we can proclaim the achieved results as final and relatively reliable.

When evaluating the results for particular interest rates, we can say right from the start that the influence of the interest rate on overnight deposits is insignificant. However, due to very low rates in this financial product, households are not likely to be influenced by them and so this result cannot really be said to be surprising. The situation is much more complicated when looking at the results for the interest rate on mortgages. In model M1, this coefficient appears to be significant while the results of M2 do not allow us to claim the same. Although the very influence of this variable is unclear, we can say that if households are truly influenced by this type of interest rate, the income effect prevails, which implies that a higher interest rate does not actually dissuade Czech households from mortgage loans too much, but higher costs in the form of elevated rates are absorbed into the household budget, which is reflected in a lower propensity to save.

The influence of interest rates on consumer credit is no doubt statistically significant. The substitution effect is obviously stronger than the income effect in this relationship, which only reflects the fact that Czech households respond to higher rates with deferred consumption and thus with a lower demand for this banking product rather than by lowering their propensity to save. Finally, the significant and relatively stable coefficients of interest rates on overdraft loans and credit cards appear to be a slight surprise, since that is not where we would expect to find this causality. Furthermore, although these products are relatively close substitutes, their effect on the average propensity to save is exactly the opposite according to the results. While the substitution effect dominates for the overdraft loans, the influence of interest rates on credit cards is negative and so it better reflects the classical position of households in the role of the borrower. One of the most likely explanations for this phenomenon may be the credit card interest-free period, which may actually reverse the household consumption decision making compared to situations of using overdraft loans (without any interest-free period).

It is also important to briefly highlight the control variables, although they are not the primary focus of this research. We can conclude that, among other significant determinants of the savings rate, there are (as expected) relative income, proxy for state

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8   Results of the Sargan-Hansen and Arellano-Bond tests and estimates for all the other control variables could not be displayed due to the limited length of the article. They can be obtained by contacting the author.

financial security for old age (ratio of old-age pension to average wage) and, in line with the life-cycle hypothesis, also the average age of the population. Conversely, the impact of the proxy for public saving (the share of general government balance to nominal GDP) is not significant and so we can only bring forward another slight doubt regarding the validity of the Barro-Ricardo equivalence.

Surprisingly, according to the results of both models, the saving behaviour of Czech households (at least when observing annual data) is not a dynamic process, that is, it is not determined by its lagged values. In that case, we can simply estimate both models without a complicated system of instruments, since endogeneity of regressors that are not lagged-dependent can be easily eliminated by the use of a within estimator.

Table 2: Estimation results using within estimator

	M1	M2
i_1_d	0.056 (0.036)	0.056 (0.036)
i_3	0.017*** (0.004)	0.017*** (0.005)
i_4_d	−0.015* (0.007)	−0.015 (0.01)
i_5_d	0.034*** (0.007)	0.033*** (0.008)
i_6	−0.03*** (0.006)	−0.03*** (0.006)

Notes: The first number is the coefficient value. The number in the parentheses stands for the standard error. The symbols ***, **, * show the statistical significance at 1%, 5% and 10% respectively.

Source: Own calculations and processing in Stata 15.

The main results obtained from the use of the fixed effects estimator are summarised in Table 2. We note that both models pass the Wooldridge (no-autocorrelation) test, the Wald (homoscedasticity) test and the Jarque-Bera (normality) test at 5%, although in the case of the Wald test they pass only at 10%. Therefore, in line with the previous results and to ensure the homoscedasticity assumption, we use the robust estimation of random error.

The results achieved by the within estimator are not surprising now. Compared to the GMM results, the signs, the magnitude and standard error (and thus the statistical significance) of all the coefficients barely differ and thus they only confirm the outcome of the previous analysis, that is, the non-dynamic nature of household savings rates. Moreover, the simple fixed effect estimation may also serve as an additional robustness check, which only proves the stability and reliability of the results achieved.

6. Conclusion

The aim of this work was to verify the causal relationship of client interest rates and the average propensity to save of Czech households. For four out of five interest rates that we used, the above-mentioned relationship was verified. The substitution effect prevailed in two cases; the income effect was dominant for the other two rates. Thus, it is obvious that in the environment of the Czech Republic, the influence of a single monetary interest rate would be ambiguous and probably also relatively weak. Therefore, it is not possible to assume a negative or positive impact of the interest rate on the propensity to save without understanding the particular type of interest rate.

While the negative impact of the interest rate on mortgages may still be uncertain (it is significant in model M1 and insignificant in model M2), all the other results are relatively stable, robust and thus may be claimed as final and reliable. We can conclude that the interest rate on overnight deposits does not have a significant influence on the propensity to save, the interest rates on consumer credit and on overdraft loans influence the savings rate positively, while the credit card receivables interest rate has a significant negative impact. Another interesting conclusion of our analysis is the finding that the savings rate of Czech households is not of a dynamic nature. While this result may be marked as quite surprising, it may be relatively easily explained by the annual nature of the dataset. In other words, a period of one year may simply be too long to enable the dynamic process of the savings rate to be visible.

There was a relatively large innovation compared to studies investigating a similar topic, namely the distribution of households into groups according to their position in the distribution of net income. However, the use of a set of client interest rates instead of one monetary policy rate eventually turned out to be an even greater benefit. As expected, it was proven that economic units respond differently to different types of client rates. Once a negative relationship prevails, in the case of a different type of rate, households can respond positively in their tendencies to save. This fact is likely to be an explanation for the current contradictory results when using a single monetary interest rate, where the impact on the savings rate is actually determined by a set of effects from individual client rates.

It is also necessary to underline at this point that the conclusion of this paper is not that there is no sense in investigating the influence of the monetary policy rate on the savings rate. This paper simply explains that due to the contradictory impacts of the income and substitution effects at the level of client interest rates, the final effect of the monetary policy rate may be lost in the transmission channel. With the knowledge of the interest rate pass-through between the monetary policy rate (or the financial market rate) and client

rates[9] and the pass-through between client rates and the savings rate, we are now able to more precisely describe and understand the true nature of the interest rate–savings rate relationship. Although there are studies investigating the impact of interest rate shocks on the behaviour of Czech households[10], none of them focuses on the influence of client rates on the savings rate while discussing the contradictory impacts of the income effect and the substitution effect. From this perspective, our analysis brings forward original and unique results describing the details of the transmission from interest rates to households.

To conclude, we need to emphasise one of the major deductions that is implied by the results of this study. That is, unlike most of the current empirical research, the ambiguous and unstable relationship between the monetary policy interest rate and the propensity to save at an aggregate level is not a surprise or source of confusion now. Rather, it is actually a logical and inevitable consequence of the heterogeneity across the effects of client interest rates. Our approach thus potentially opens up a new way of analysing the interest rate pass-through in relation to households. It finally reveals that both the problem and the solution to an empirical puzzle does not have to lie in the very nature of the given relationship, but rather in the way in which we look at it, in the methods and the data that we use.

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9   For the case of the Czech Republic, see for example Gregor and Melecký (2018) or Havránek *et al.* (2016).

10   Represented especially by stress tests conducted the Czech National Bank: for instance Malovaná *et al.* (2018) or Galuščák *et al.* (2016).

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