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Abstract:
This paper deals with the risk management of savings accounts. Savings accounts are non-maturing accounts bearing a relatively attractive rate of return and two embedded options: a customer's option to withdraw money at any time and a bank's option to set the deposit as it wishes. The risk management of saving accounts remains a big challenge for banks and simultaneously raises serious concerns by some regulators. In this paper, we focus on the interest rate risk management of savings accounts. By constructing the replicating portfolio and simulating six scenarios for the market rate and client rates, we show that under the severest scenario, some banks in the Czech Republic might face a capital shortage up to 22%

in next two years if market rates start to increase dramatically. We conclude that savings accounts are risky instruments that cannot be hedged by standard risk mitigation techniques. Since savings accounts in the Czech Republic are not subject to any special regulation yet, we propose imposing stricter regulation and supervision (the Belgium framework might be an inspiring model to consider).

Keywords: demand deposits, interest rate risk, replicating portfolio, risk management, savings accounts, simulations

JEL: C150, G21, G11

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1 Introduction

Banks are financial intermediaries that are engaged in a maturity transformation from short-term funding to long-term financing. Banks usually collect money from retail customers through two "old" channels: sight deposits (current accounts), term deposits and "new" channel: savings accounts. In this paper, we focus on the later. Savings accounts include two embedded options: (i) a customer has the right to withdraw money in any time and (ii) a bank can freely change the deposit rate. The caveats of savings accounts' risk management have been discussed by several researchers in past years. For instance, Maes and Timmermans (2005) claim that savings deposit accounts raise important financial stability issues in Belgium because of their significant proportion of banks' liabilities and their huge maturity mismatching. The significance of savings accounts has been increasing recently but they do not represent an important source of funding for the Czech banking sector yet. This increase is mainly alarming due to the fact that it happens during a period of low market rates. This means that banks collecting large amounts of funds through savings accounts can reinvest those funds only into low yield bearing instruments (either on the market or as loans and mortgages). However, savings accounts are characterized by a relatively high deposit rate stemming from client's expectations on the one side and banks´ marketing strategies on the other side.

The overall aim of this paper is to describe the risk management of savings accounts from both theoretical and practical points of view. We aim to show that low market rates and aggressive acquisition of clients through a high deposit rate bearing savings accounts will result in significant interest rate risk in some Czech banks in the future when market rates increase. Such research is in line with current international research. For example, International Monetary Fund (2013) and Bank of England (2013) warn that suddenly increasing market rates will have a negative impact on banks. The following text is structured as follows: Section 2 discusses the characteristics of savings accounts and the dynamics of savings accounts in the Czech Republic. It also describes the risk management of savings accounts and identifies six key savings account risks. Section 3 provides

empirical research of the interest rate risk management of savings accounts in the Czech Republic. Section 4 summarizes the paper and states final remarks.

2 Theoretical background

2.1 Savings accounts and clients´ expectations

We define savings accounts as a deposit on demand characterized by unlimited disposability (the client can withdraw all balance on notice), high deposit rates and low fees for maintenance and account operations. Savings accounts are non-maturing liabilities with client friendly characteristics as they combine common feature of current accounts (withdrawal on a notice) with common features of long-term deposits (higher deposit rates). Besides, savings accounts´ deposit rate can be changed at any time by a bank. The possibility to change a deposit rate increases flexibility of a bank since it can quickly react to changes in market rates. In practice, deposit rates are not changed immediately due to administrative and transaction costs, however. All these described characteristics are embedded in savings accounts, what transforms them into a product with embedded options, i.e. a product with uncertain timing of future cash flows and uncertain pricing.

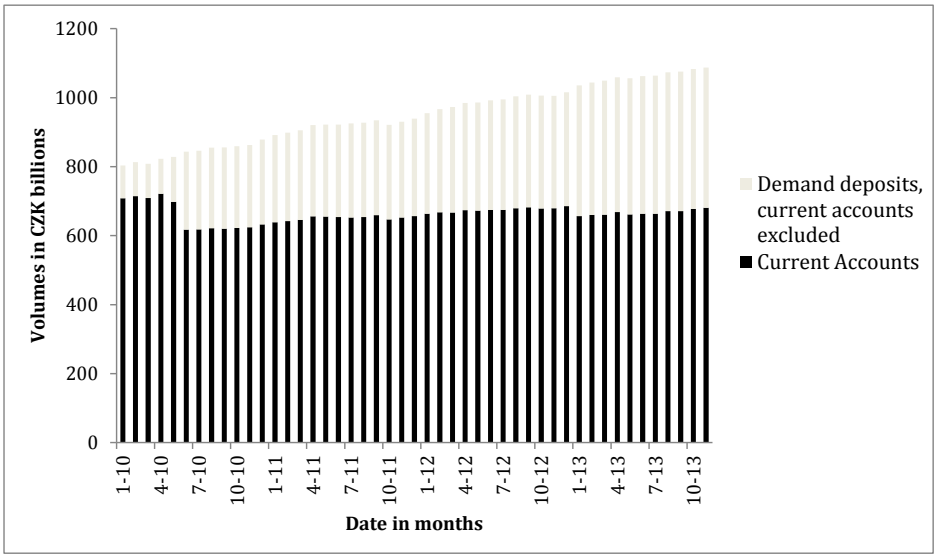
Concerning savings accounts, behavioural patterns of clients are of utmost importance. We distinguish two important behavioural classes of savings accounts' clients - active and passive clients. The behavioural patterns of these clients can be easily described by a microeconomic theory of preferences as in Collel et al. (1995). Passive clients are interest rate insensitive, i.e. they are indifferent among different deposit rate bearing savings accounts and their deposits can be considered as a safe liability with relatively known risk by banks. Active clients, on the other hand, strictly prefer a high deposit rate bearing savings accounts and have a tendency to change banks quickly to obtain a best deal on the market. Therefore, active clients are extremely interest rate sensitive. This is crucial for the risk management of savings accounts as active clients pose a huge uncertainty in bank´s ability to price savings accounts accordingly, i.e. by their risk. However, banks are usually not able to distinguish between passive and active clients, which results in unified deposit rate offer to both classes of clients that is high enough to attain active clients, which is

costly. There is evidence that a large portion of savings accounts' clients in the Czech Republic are active clients (Tůma, 2013), what makes our research highly relevant.

2.2 Dynamics of savings accounts in the Czech Republic

The importance of savings accounts has been increasing in the Czech Republic in the past years. Although there are no official statistics of total CZK deposited on savings accounts in the Czech Republic, as these are not reported separately by the Czech National Bank, we can approximate them. Savings accounts are included in Savings demand deposits and reported together with other demand deposits in the category Demand deposits that reached CZK 1,087 billion as of 30 November 2013. From this, current accounts amounted to CZK 680 billion and remaining categories to CZK 407 billion. Figure 2.1 shows a decrease in current accounts resulting from the transfer of savings accounts from current accounts to Savings demand deposits as of 30 June 2010. Since then, the volume of Demand deposits, current accounts excluded, has been growing steadily. This increase might be attributed to increasing demand for savings accounts. We estimate aggregate savings accounts to be worth approximately CZK 300 billion as of 30 November 2013. We expect further increases in aggregate savings accounts due to their ongoing attractiveness and stable high yields in comparison with other deposit products despite low market rates.

Figure 2.1: The savings accounts´ dynamics from 31 January 2010 to 30 November 2013



Source: Authors based on the data from ARAD time series database provided by the CNB

The aim of this paper is not to provide the complete description of dynamics of deposit rates offered on all savings accounts in the Czech Republic. Due to this, we only mention the development of deposit rates briefly. Generally, the peak in savings accounts´ deposit rates occurred during the end of 2011 and the first half of the year 2012, being connected to the entrance of Air Bank with its TOP 3 policy. Since then, we observe the gradual decrease in deposit rates, which is an obvious consequence of historically low market rates during this period. On the other hand, even though savings accounts´ deposit rates were significantly lower during January-August 2013 than they were during January-August 2012, these low rates were still above long-term yields that were achievable on the market. For example, during January 2013 a majority of deposit rates on savings accounts amounted to between 1.5% and 2%, what makes them comparable to the 10Y Czech government bonds average monthly yield during January 2013 of 1.41%. During September 2013 – January 2014 market rates continued to be low, which led to a further decrease of deposit rates to average of the TOP 3 of 1.3% in January 2014. It should also be stated that different banks offer different deposit rates on savings accounts. In 2012 the average client rate in big banks in the Czech Republic reached approx. 1.5% compared to more than 2% in small banks. On the other hand, in early 2014 the difference between the banks decreased and big

banks offered an average 1% rate compared to small banks´ average rate around 1.3%. These numbers imply that, even with a surplus liquidity on the Czech banking market, big banks are reluctant to lose their clients (i.e. there is a risk that a client would leave a bank not only with a savings account, but also with other depository products).

2.3 Key risks of savings accounts

Banks are exposed to several risks arising from savings accounts. Sources of these risks are embedded characteristics of savings accounts as well as other standard banking risks. We identify six key savings accounts risks: liquidity risk, systemic risk, reputational risk, model risk, concentration risk and market risk. We argue that all these risks have been increasing substantially in last years due to the accelerating pace of information and communications technology (ICT) in banking[1]. For example, the internet and mobile banking enable clients easily transfer their money on notice., what remains true for transfers on savings accounts.

First, liquidity risk can be defined as the probability of the situation when a bank cannot meet its obligations as they become due (Mejstřík et al., 2009). For savings accounts, liquidity risk is mainly represented by a possible inability to cover massive withdrawals of active clients. During low market rates, a liquidity risk of savings accounts is moderate. On the contrary, when market rates increase, the increasing competition will lead to an increase in the liquidity risk of savings accounts as active clients will move their savings to banks that offer high deposit rate savings accounts. Therefore, liquidity risk would result in unstable balances on savings accounts, what would drive a bank to reinvest savings accounts only into low-yield bearing assets that would not cover a high deposit rate expense.

Second, systemic risk can be defined as a risk that influences the whole industry through market contagion. There are three systemic risk concerns of savings accounts in the Czech Republic. First, the current lower share of savings accounts on Czech banking sector´s liabilities does not imply their significance yet (approx. 10% share as of November 2013), but they have been becoming extremely popular among clients. Second, in addition to this popularity, possible cash inflow to savings accounts might be expected from buildings

[1] Sometimes called as cloud banking since a bank operates in "a cloud" of ICT services.

savings due to decreasing state support on this product (Horváth and Teplý, 2013). Third, corporate governance of the banks resided in the Czech Republic and highly depended on savings accounts plays a role. A majority of new and the most active banks in savings accounts´ marketing campaigns is usually owned by large foreign owners. As the Czech banking sector reports capital and liquidity surplus, the parent companies lacking liquidity may have a tendency to, by offering high deposit rates, remove liquidity from the Czech Republic to stand their problems on home or international markets.

Third, reputational risk is defined by BCBS (2009) as "the risk arising from negative perception on the part of customers, counterparties, shareholders, investors, debt-holders, market analysts, other relevant parties or regulators that can adversely affect a bank's ability to maintain existing, or establish new, business relationships and continued access to sources of funding." Savings accounts are a source of reputational risk due to the fact that clients expect a high deposit rate, but a bank may not be able to attain it.

Fourth, model risk means the risk that a bank uses an incorrect model in the risk management of savings accounts (Maes and Timmermans, 2005). A bank needs to correctly define several models and based on available historical data, what may not be always sufficient. Bodemer (2011) points out that risk management of savings accounts relies on the assumption that a bank has all these models correctly defined. However, misspecifications of the model can arise, especially when a model neglect exogenous factors.

Fifth, concentration risk is the risk of low diversification of assets. In case of savings accounts, it could be represented by a fact that a bank would reinvest savings accounts only into a limited set of bank products such as consumer loans or credit cards. In the Czech banking sector, concentration risk remains important chiefly for small banks that offer a smaller palette of loan products than big banks.

Finally and the most importantly, market risk results from changes in the value of an instrument or portfolio of instruments stemming from market conditions. Resti and Sironi (2007) present five market risk categories: exchange rate risk, interest rate risk, equity risk, commodity risk and volatility risk. In this study, we mainly address the interest rate risk.

2.4 Interest rate risk management of savings accounts

In terms of interest rate risk management, savings accounts are risky liabilities that cannot be hedged by standard risk mitigation techniques used for other bank´s liabilities such as sight or term deposits. Two important issues arise.

First, savings accounts have zero contractual maturity similar to current accounts. However, as opposed to current accounts, the savings accounts´ deposit rate is usually much higher than current accounts´ deposit rate (0.01% on current accounts versus 1% and more on savings accounts in the Czech banking sector in March 2014). Furthermore, a deposit rate on current accounts is, in the majority of Czech banks, absolutely independent from the market development (i.e. the rate remains at 0.01% regardless whether government bonds yield at 2% or 5%. On the contrary, the deposit rate on savings accounts reflects movements in market rates. Therefore, the margin from savings accounts reinvestment is more interest rate sensitive. Without any competition and transactional costs, savings accounts interest rate risk would be minimal as all banks would price savings accounts in such a way that their margin would be absolutely stable in time as all changes in market rates would be directly transferred to the client. In the competitive environment with transactional costs, however, deposit rates are not adjusted immediately and are derived not only from underlying market rates (cost of funding), but also from competitors´ pressured and clients´ behavioural patterns. This makes the interest rate risk management of savings accounts different from current accounts.

Second, the approximation of the effective maturity of savings accounts. Even though the contractual maturity of savings accounts is zero, the reinvestment or effective maturity of savings accounts is higher as a large portion of depositors leaves their balances in a bank. A rational bank therefore redistributes the core of savings accounts into medium-term and long-term investments and provides a positive maturity transformation. However, a bank should estimate the reinvestment maturity of savings accounts properly to ensure that it attains available funds to simultaneously cover unexpected withdrawals and to attain relatively stable margin from savings accounts. Ideally, the margin from savings accounts should compensate a bank for a higher deposit rate, transactional costs and also for risks that arise from savings accounts.

2.4.1 Theoretical models

To ensure stable margin and to estimate the effective maturity, banks in Europe usually employ replicating portfolio models and simulations. There are two classes of replicating portfolio models. First, static replicating portfolio models are based on once in a time calculation of amounts/weights of savings accounts reinvested into pure-discount instruments with various maturities (Maes and Timmermans, 2005; Kalkbrener and Willing, 2004). These weights are estimated by the optimization that focuses either on the maximization of the margin or the minimization of the variance of the margin. The maturity of savings accounts is then defined as the duration of the replicating portfolio. Second, there are dynamic replicating portfolio models (Frauendorfer and Schurle, 2006; Dewachter et al., 2006). Dynamic replication includes changes in weights that are continuous, i.e. weights change in every point in time based on the joint simulated development in market rates, deposit rates and balances on savings accounts. Frauendorfer and Schurle (2006) claim that dynamic replicating portfolio approach leads to more optimal division into different maturity tranches in such a way that the margin can be substantially larger under the dynamic approach than under the static approach. The construction of both classes of the replicating portfolio models requires the knowledge of the historical development of market rates, deposit rates and volumes. These processes must be estimated correctly; otherwise a bank is exposed to the model risk. Apart from the class of replicating portfolio models, there are models that aim to assess the present value of savings accounts as Monte Carlo simulation approach and the Option Adjusted Spread mentioned by Maes and Timmermans (2005) or the no-arbitrage multi-factor flexible-affine term structure model in Dewachter et al. (2006).

2.4.1.1 The replicating portfolio

Replicating portfolios are ideally constructed to replicate cash-flows from non-maturing liabilities in such a way that the replicating portfolio consists of instruments with known maturities, which cash-flows replicate cash-flows from non-maturing liabilities. Banks invest into these instruments under different weights in such a way that the margin is maximized or the least volatile. The duration of the replicating portfolio is then calculated as the weighted duration of these instruments, and the interest income from the replicating

portfolio is used to cover interest expense and provides income to a bank. To ensure liquidity, banks usually divide volumes into core and volatile parts. The core part is reinvested into medium-term and long-term instruments. The volatile part represents amounts that change on savings accounts on a daily/monthly basis. The volatile part of savings account is invested into short-term instruments (usually from overnight tenors to 3M) that ideally mature in such a way that maturing tranches are able to cover daily withdrawals. The replicating portfolio estimation in banks is based on the optimization described, for example, in Maes and Timmermans (2005):

$$min\sigma_M \; or \; maxM, M = (II_{RP} - C) \tag{2.1}$$
$$s.t.: \sum_{i=1}^{n} II_i w_i = II_{RP}, \sum_{i=1}^{n} w_i = 1, w_i \geq 0, \; \forall i, V_{i,t,not\ invested} = 0, t = 1, \dots, T$$

In the equation (2.1) we either minimize the standard deviation of the margin σ_M or maximize margin M. II_{RP} is the interest income from the replicating portfolio that equals to the sum of interest incomes of all individual investments and w_i is the weighth of each investment and as no short-selling is allowed, its value is always positive or zero. C is the interest expense paid to clients and V is the outstanding volume on savings accounts that can be further divided into core and volatile part. The last condition is that all volumes are perfectly replicated for all t, i.e. no money lays back.

C process is defined by the client rate and outstanding volumes and it has a direct influence on the margin. Banks adjust deposit rates to market rates to account for changes in the margin gained from the reinvestment as well as to account for marketing and management strategies. Hence, the deposit rate is usually explained by a dynamics of market rate. The adjustment of the deposit rate of savings accounts to market rates is found to be asymmetric and lagged.

Asymmetric adjustment: Under increasing market rates, banks' reaction to adjust the deposit rate is slower than under decreasing market rates. This is due to the fact that under increasing market rates, banks want to exploit the short period of a low deposit rate and a high market rate to maximize their margins. The opposite applies to decreasing market rates. This asymmetric adjustment is documented by Paraschiv and Frauendorfer (2011),

Frauendorfer and Schurle (2006), Maes and Timmermans (2005) and also in O'Brien (2000).

Lagged adjustment: The adjustment of a deposit rate is costly. Banks have to compare costs to benefits of the adjustment, and only when benefits exceed costs, banks adjust the rate. Due to this, banks adjust deposit rates only when market rates change by a significant amount and non-temporarily. The lagged adjustment is sometimes defined as the rigidity of deposit rates and verified by several studies; for example, in Paraschiv and Frauendorfer (2011).

Stepwise structure: Deposit rates, especially on savings accounts; do not develop continuously, but in steps with long periods when the deposit rate remains constant. Stepwise structure of deposit rates is a consequence of an asymmetric and lagged adjustment.

Due to the presence of non-linear adjustment, the simple linear model cannot neatly fit the deposit rate (Paraschiv and Frauendorfer, 2011). Deposit rates can be fitted by non-linear models such as a logit in Blochlinger (2010), by the threshold model as in Frauendorfer and Schurle (2006), by the non-linear partial adjustment model as in Maes and Timmermans (2005), by the friction model by Paraschiv and Frauendorfer (2011) or the asymmetric partial adjustment model of O'Brien (2000). The second class of models exploits the long run relation between a deposit rate and market rates, as for example the error correction models by Paraschiv and Frauendorfer (2011).

Apart from the client rate model, the bank must estimate the process V as well. Balances on savings accounts are of extreme importance to a bank as these are pooled into the replicating portfolio and are reinvested into short-term, medium-term and long-term instruments. The bank needs to have at least partial information about possible future development of volumes to be able to construct a replicating portfolio that maximizes margin, while minimizing its variance. Unexpected withdrawals lead to liquidity and market risk pressures as a bank needs to fire sell a part of its portfolio to remain liquid.

It is a well-documented fact that volumes on savings accounts decrease when market rates increase as more attractive investment opportunities arise. The opposite applies for decrease in wholesale market rates. However, these well-known facts are not sufficient for the prediction of future balances. A bank also needs to estimate the impact of several factors such as market rates, spread between market rates and deposit rates, term deposits yields, wholesale market indices, monetary aggregate M1 (inflation), and dummies that account for seasonal effects such as Christmas, after-Christmas sales in January, the 13th wage period and the holiday period in summer. To estimate how these factors influence volumes, a bank can use methods like linear models or the VAR approach. However, the development of balances deposited is still uncertain, as well as the development of factors that influence them. For this reason, a bank always reinvests a part of the portfolio into short-term instruments to sustain unexpected withdrawals up to a certain extent.

Models describing dynamics of volumes can be divided into two classes. The first class consists of models where authors estimate significant factors for changes in volumes using linear and VAR models with numerous explanatory variables as in Paraschiv and Frauendorfer (2011). The second class is more interesting from a simulations point of view as it explains deposit balances by using less factors, usually only market or deposit rates (Due to the collinearity problem, only one market or deposit rate can be included in the model.). This class of models can be further decomposed into models assuming that volumes develop constantly around some trend as in Kalkbrener and Willing (2004) or Frauendorfer and Schurle (2006), and into models including the rate of decay of balances as in Dewachter, et al. (2006).

2.4.2 The model of the interest rate risk of savings accounts

In our analysis, we employ the modification of the static replicating portfolio approach described above. We intend to investigate whether a similar investment strategy results in different outcomes for the capital in banks that use different risk management of savings accounts (differences in the risk management are driven by the competition, i.e. by the willingness of a bank to increase the deposit rate) under random simulations as well as under different scenarios for the market rate. Therefore, we define the reinvestment strategy of a bank, i.e. weights w_i are defined. On the contrary, a replicating portfolio

approach described above intends to derive w_i. Otherwise, we build our analysis in the similar manner as described above, i.e. we define models for a market rate, a deposit rate and outstanding volumes.

The market rate model was obtained by the calibration of the Vašíček model to the daily historical values of 2W repo rate from 1 January 1999 to 28 February 2013 using the procedure in Brigo et al. (2007). The yield curve representing reinvestment opportunities is derived from the market rate at each moment in time using procedure in Brigo and Mercurio (2001). The deposit rate adjustment to the market rate is based on the asymmetric adjustment model defined similarly as models by Paraschiv and Frauendorfer (2011), Kalkbrener and Willing (2004), Maes and Timmermans (2005) and Frauendorfer and Schurle (2006). The main explanatory variable in the deposit rate model is the calibrated 2W repo rate. The policy rate is similarly used by several authors, see Paraschiv (2011). Due to the lack of the data, we cannot assess the aggregate development of savings accounts balances in retail in the Czech Republic by any calibration to the historical data. Therefore, we let savings accounts´ volumes in retail to grow only at the deposit rate, i.e. by recapitalization, with starting value being CZK 100 million for all types of banks. Following set of equations defines our models:

Market rate model:

$$d\mathrm{m_t} = \mathrm{a}(\mathrm{b} - \mathrm{m_t})d\mathrm{t} + \sigma d\mathrm{W_t}$$

$$\mathrm{B}(\mathrm{t},\mathrm{T}) = \frac{1}{\mathrm{a}}\left[1 - e^{-\mathrm{a}(\mathrm{T}-\mathrm{t})}\right]$$

$$\mathrm{A}(\mathrm{t},\mathrm{T}) = exp\left\{\left(\mathrm{b} - \frac{\sigma^2}{2 * \mathrm{a}^2}\right)[\mathrm{B}(\mathrm{t},\mathrm{T}) - \mathrm{T} + \mathrm{t}] - \frac{\sigma^2}{4\mathrm{a}}\mathrm{B}^2(\mathrm{t},\mathrm{T})\right\}$$

$$\mathrm{yield}(\mathrm{t},\mathrm{T}) = -\ln\left[\mathrm{A}(\mathrm{t},\mathrm{T})e^{-\mathrm{B}(\mathrm{t},\mathrm{T})\mathrm{m_t}}\right]/\mathrm{T}$$

The client rate model: (2.2)

$$\nabla \mathrm{c_{i,t}} = \rho_\mathrm{i} \quad \text{if } \left|\mathrm{c_{i,t-1}} - \mathrm{m_t}\right| \geq \alpha_\mathrm{i} \text{ and } (\mathrm{m_t} - \mathrm{m_{t-1}}) > 0 \text{ and } \mathrm{m_t} > 0$$

$$\nabla \mathrm{c_{i,t}} = -\tau_\mathrm{i} \quad \text{if } \left|\mathrm{c_{i,t-1}} - \mathrm{m_t}\right| \geq \beta_\mathrm{i} \text{ and } (\mathrm{m_t} - \mathrm{m_{t-1}}) < 0$$

$$\nabla \mathrm{c_{i,t}} = 0 \quad \text{if } \left|\mathrm{c_{i,t-1}} - \mathrm{m_t}\right| < \beta_\mathrm{i} \text{ and } (\mathrm{m_t} - \mathrm{m_{t-1}}) < 0$$

$$\nabla \mathrm{c_{i,t}} = 0 \quad \text{if } \left|\mathrm{c_{i,t-1}} - \mathrm{m_t}\right| < \alpha_\mathrm{i} \text{ and } (\mathrm{m_t} - \mathrm{m_{t-1}}) > 0$$

$$\nabla \mathrm{c_{i,t}} = 0 \quad \text{if } (\mathrm{m_t} - \mathrm{m_{t-1}}) = 0$$

$c_{i,t} \geq \mu_i, \beta_i \geq \alpha_i > 0$

Volumes:

$\nabla V_{i,t} = \left(\sqrt[1/12]{1 + c_{i,t}}\right) V_{i,t-1}$

In equations (2.2) m_t is a short-term interest rate, a is the speed at which the interest rate returns to its mean b, σ is volatility at time t, i stands for a bank I, W_t is a Wiener process, $c_{i,t}$ is the deposit rate, ρ_i defines the adjustment upwards in each bank and τ_i defines the adjustment downwards. The α_i is the threshold value that defines the maximum limit of the absolute difference between the deposit rate and the market rate in each bank during increasing market rates, β_i is the threshold value that defines the maximum limit of the absolute difference between the deposit rate and the market rate in each bank during decreasing market rates. The bank adjusts the market rate when this limit is exceeded. Finally, μ_i is the downward limit value for the deposit rate in the bank and $V_{i,t}$ is the volume on savings accounts.

The reinvestment and the pricing (a deposit rate) of savings accounts defined in our analysis represents an average strategy of the reinvestment of banks in the Czech Republic (according to our market knowledge). In short, we divide banks into three categories (i.e., I = i,ii,iii) based on their pricing of savings accounts. **(i)** ***The low-cost bank.*** During the last 5 years, many new banks have entered the market. Those banks focus on offering low-cost (a zero-fee policy) deposit products with relatively high rate of return that can be operated entirely or almost entirely through the internet. We observe that new banks focus on savings accounts as on a primary source of funding. In the extreme case, savings accounts may amount up to 90% of their liabilities.[2] This directly means that some new banks have a lower share of deposits on current accounts in total liabilities when compared to the well-established banks. Additionally, a higher share of savings accounts in banks´ liabilities implies a higher funding costs, i.e. banks with a smaller share of current accounts on total liabilities face high funding costs. Furthermore, their clients are usually more active.

[2] For example, Air Bank reports to raise its liabilities from CZK 2.3 billion to CZK 31 billion during 2012. Given the fact that only CZK 26 million from CZK 2.3 billion on 31 December 2011 and CZK 458 million in 31 December 2012 were placed on current accounts, we can conclude that (i) a majority of Air Bank deposits are savings accounts (ii) deposits in Air Bank increase significantly. Furthermore, Air Bank offers a current account that has also high deposit rate in comparison with other current accounts offered on the market. Moreover, Equa bank also reports significant increases in its liabilities.

Therefore, these banks need to attain relatively high deposit rates on savings accounts; a high deposit rate is the most important factor that attracts and retains their clients. For these banks, we expect aggressive pricing of savings accounts. **(ii)** ***The traditional bank***. A *traditional bank* is a well-established bank that has a diversified funding source. Clients are usually more loyal to *the traditional bank* as *the traditional bank* can offer them a wide portfolio of services and products. This loyalty implies higher stability of deposits in *the traditional bank*. Last but not least, *the traditional bank*s usually charge higher fees compared to *the low-cost bank*s, which represents an important source of income. For this type of bank, we assume less aggressive deposit pricing as a well-established bank does not need to offer the highest deposit rate on the market. **(iii)** ***The third type bank*** is a residual category since not all banks can be considered to be either as *the low-cost* or the *traditional bank*s. For more details about pricing strategies, see Džmuráňová (2013).

In our model, each bank type reinvests savings accounts volumes of CZK 100 million in retail into the replicating portfolio under weights w_i as defined in Table 2.1 with the condition that $\sum_{i=1}^{n} w_i = 1$ and that no short selling is allowed. For *the low-cost bank*, we define two types of portfolios: non-aggressive and aggressive. Aggressive portfolio shows that riskier investment of savings accounts results in positive net interest income even under a relatively high deposit rate, but at the cost of a risky position in high-yield instruments, such as consumer loans or mainly corporate bonds. We partially base our aggressive portfolio on the interview in Face to Face by Tinl (2012), where Erich Čomor, the CEO at Air Bank, mentions the Air Bank's reinvestment strategy.

Table 2.1: Weights of different reinvestments in the replicating portfolio for scenarios

The traditional **and the** ***third type bank***	***The low-cost bank*** **non-aggressive portfolio**	***The low-cost bank*** **aggressive portfolio**
10% of deposits is invested into O/N rate.	10% of deposits is invested into O/N rate.	10% of deposits is invested into O/N rate.
10% of deposits is invested into 3M.	10% of deposits is invested into 3M.	10% of deposits is invested into 3M.
40% of deposits is invested into 10Y.	40% of deposits is invested into 10Y.	33% of deposits is invested into 10Y.
40% of deposits is distributed as loans and mortgages to clients:	40% of deposits is distributed as loans and mortgages to clients:	14% of deposits is distributed as loans and mortgages to clients:

1. 13.3% of deposits is invested into 1Y fixed rate consumer loans for CZK 30,000 with r = 20%. 2. 13.3% of deposits is invested into 5Y fixed rate consumer loans for CZK 100,000 with consumer loans' interest rate of r =15%. 3. 13.3% of deposits is invested into 20Y fixed rate (fixing for 5 years) mortgages for CZK 1,000,000 with 4% rate.	1. 13.3% of deposits is invested into 1Y fixed rate consumer loans for CZK 30,000 with r = 15%. We let consumer loans' interest rate r in *the low-cost bank* being lower than in *the traditional bank* and *the third type bank* as we found that these are lower on average. 2. 13.3% of deposits is invested into 5Y fixed rate consumer loans for CZK 100,000 with r =10%. 3. 13.3% of deposits is invested into 20Y fixed rate mortgages (fixing for 5 years) for CZK 1,000,000 with 4% mortgage rate.	1. 5% of deposits is invested into 1Y fixed rate consumer loans for CZK 30,000 with r = 15% 2. 5% of deposits is invested into 5Y fixed rate consumer loans for CZK 100,000 with r =10%. 3. 4% of deposits is invested into 20Y fixed rate mortgages (fixing for 5 years) for CZK 1,000,000 with 4% rate. 33% of deposits is invested into long-term (maturity higher than 5 years) foreign-owned company bonds that provide 10% annual yield.

Source: Authors

All instruments in the replicating (reinvestment) portfolio are hold to maturity and rolled over when matured. The increasing balance on savings accounts is redistributed under these weights in each estimation step so that whole balance is always invested in each step. We always let each bank reinvest all increments in savings accounts' balance + interest income from the previous month investment before the interest expense paid to depositors as we include no withdrawals into the model. This simplification reflects the fact that whole balances + interest increments before the interest paid to depositors are assumed to remain in a bank that later reinvests this money. A rational bank reinvests all the money, i.e. not paid interest expense liability is in fact asset bearing interest.

Consumer loans and mortgages pay interest monthly and interest + principal returns (calculated as annuity) are rolled over as new consumer loans and mortgages. The inclusion of loans and mortgages is also an important difference between our and classical replicating portfolio approach. By adding these, we are able to derive the more realistic revenue of a bank. Money market instruments pay interest + par value at maturity and 10Y government and long-term company bonds pay yields annually. We derive monthly steps, i.e. in each month a bank receives maturing investments, repayments + interest from loans and

mortgages and yields from bonds and rolls them over. Consumer loans' and mortgages' interest rates as defined in Table 2.1 are initial values of those. As soon as market rates start to increase, banks will increase consumer loans' and mortgages' interest rates on newly provided consumer loans and mortgages as well. To account for this, we let consumer loans' and mortgages' interest rates to grow at the growth of the market rate.[3] Loans and mortgages are risky assets as there is always some percentage of defaults. We include defaults into our analysis and we define defaults to be 2% in *the third type bank* and *the traditional bank* and 5% in *the low-cost bank*s.[4] In simulations we cease the inclusion of consumer loans and aggressive strategy and we let each type of a bank to reinvest solely on the money and bond market.

Each reinvestment position in the portfolio generates income monthly. The deposit rate expense[5] is also paid monthly. Hence, the net monthly income is calculated as the monthly income from all reinvestment positions minus the deposit rate expense. All monthly net incomes are than summed on a yearly basis. The cumulative net interest income is calculated as the sum of all net incomes in given years. The same procedure of the calculation is employed in all types of banks. The cumulative net interest income after T periods directly influences bank's capital. When a bank has positive cumulative net interest income, this income is simply added to the capital at the end of the scenario and it exactly increases by the net interest income. The initial value of capital is set to CZK 10 million. A bank can have monthly interest income negative, if the monthly interest income from all position is lower than the monthly interest expense. If a majority of monthly incomes is negative, the total yearly income is also negative, and obviously the cumulative net interest income is negative as well. In such case, we assume that the net loss is paid from the bank's capital at the end of the scenario or simulation at the period T. This means that a net loss in our model does not influence the bank's reinvestment policy; it only decreases its capital

[3] Dynamics of consumer loans' interest rates are as follows: $\Delta r_{i,t} = r_{i,t-1} + m_t - m_{t-1}$, i = $The\ traditional\ bank$, the $low - cost\ bank$ and $the\ third\ type\ bank$, $t = 1 \ldots, T$, $r_{i,t}$ is the consumer loans' interest rates.

[4] We let the *low-cost bank* to have higher defaults as we have found that, for example, Equa bank reported the share of receivables in the expectation of default in all receivables to be 22.98% as of 30 September 2012 and 27.05% as of 31 December 2012.

[5] When calculating the interest paid to depositors, we use $\left(\sqrt[1/12]{1 + c_{i,t}}\right)V_{i,t-1}$ → the interest expense equals recapitalization.

ultimately. Additionally, this simplification ensures that banks with negative monthly interest income will not have negative investments.

3 Empirical analysis of savings accounts

In this section we investigate the interest rate risk management of savings accounts in the Czech Republic, using the modified static replicating portfolio approach and simulations.

3.1 Replicating portfolio model: simulations

First, we focus on the current low-interest rate environment as it raises several concerns in the sound risk management of savings accounts. The pending low wholesale market rates imply that banks de facto cannot achieve high margins from the reinvestment of savings accounts and should therefore provide lower deposit rates. Figure 3.1(a) illustrates that the banks that started to offer savings accounts during decreasing market rates (as denoted by time *T*) have lower yields from savings accounts than the other banks that were able to reinvest savings accounts during the period of high market rates (especially in time *T-9*). This means that the sound risk management of savings accounts in banks that enter the market (or start to offer savings accounts) during low market rates should definitely be based on the strategy that the deposit rate is lower than long-term market rates.

We investigated the historical pricing of savings accounts more closely by applying a replicating portfolio approach described in the section 2.4.2. It is the common practice to derive effective pricing on the side of the interest rate risk of demand deposits by the relation of the client rate and market rates. Therefore, in this part, we employ simpler replicating portfolio than the one in Table 2.1. A simplified version assumes only the reinvestment on the market, for details see Table 3.1.

Table 3.1: A simple replicating portfolio

Tranch	Weights
O/N (overnight)	13.33%
3M	13.33%
6M	13.33%
1Y	13.33%
5Y	23.33%
10Y	23.33%

Source: Authors

In Figure 3.1(b) we derive sustainable yields from the reinvestment of savings accounts into the simpler replicating portfolio defined in Table 3.1 in recent years. Evidently, any deposit rate higher than 2% would result in the net interest rate loss after 2010 given a bank would invest only on the market even before the inclusion of the obligatory deposit insurance expense. We stress that many deposit rates were above 2% during 2011. The situation is similar in the beginning of 2014, even though deposit rates decreased significantly.

Figure 3.1(a): Theoretical bank's yield under low and high market rates,

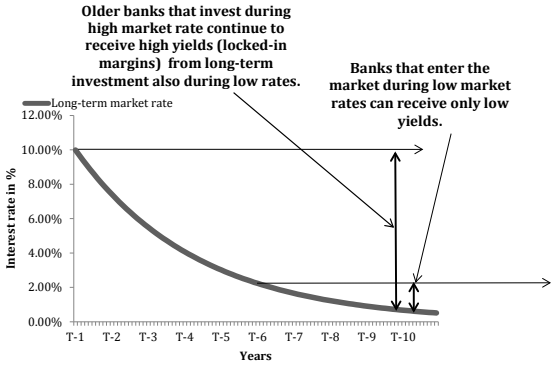
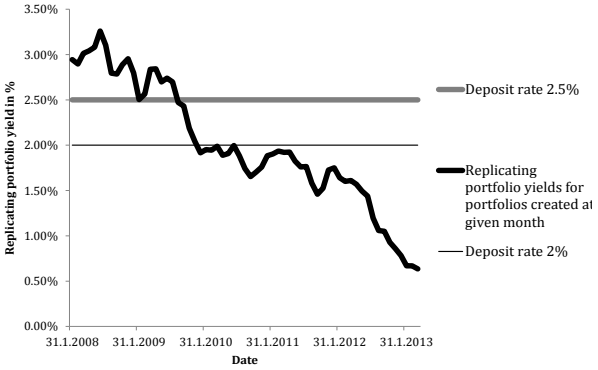


Figure 3.1(b): The yield achievable on the market in 1 January 2008 - 31 March 2013



Source: Authors

We found that margins from savings accounts are low and we expect them to be even negative in banks that provide a higher deposit rate than is the yield achievable on the market. In the case of new banks, a negative margin may result from sunk costs, i.e. a bank needs to build up its portfolio and gain clients. A new bank expects that these costs will be compensated by a powerful position on the market in the future. However, we argue that the expectation that low/negative margins will be compensated by high margins from the powerful position in the market in the future is unrealistic. This stems from the fact that savings accounts´ clients are active ones and that banks in the Czech Republic face a competitive environment in the case of savings accounts. To support this hypothesis, we simulated the development of the net interest income from savings accounts from the same portfolio as in Table 3.1 under a random development of market rates that starts during a low-yield period. We employed 1000 runs over a horizon of 2 and 5 years in our three different types of banks.

Table 3.2 summarizes average simulated net interest income from savings accounts. We find that for any type of analyzed bank, it is feasible to reinvest savings accounts only on the market. This indicates that the reinvestment of savings accounts that bear a high or a moderate deposit rate would be feasible only if banks would invest in other investment, such as consumer loans or mortgages. However, these instruments are less liquid and secure than the reinvestment on the market. This exposes banks to a higher liquidity and credit risk, but provides a higher interest income. The result we obtained is in line with conclusion we derived in Figure 3.1(b). We also find that the reinvestment of the core of savings accounts that starts during low market rates is not able to provide positive net interest income for a long period. The average duration of the portfolio in simulations is 3.7 years. Therefore, for increasing market rates, it will take on average 3.7 years before any type of bank will get rid of low yields high cost bearing liabilities. The result of simulations shows that savings accounts are risky liabilities for all banks.

Table 3.2: Average cumulative net interest income from the reinvestment of savings accounts after 24 and 60 months

CZK thousands	*The traditional bank*	*The low-cost bank*	*The third type bank*
24 months	-1,295.7	-4,332.1	-2,808.2
60 months	-1,701.5	-13,479.5	-6,944.28

Source: Authors' own calculations

3.2 Interest rate risk of savings accounts

We provide evidence that savings accounts are risky instruments. We find three challenges of the risk management of savings accounts in the Czech Republic: (i) insufficient hedging of all risks, (ii) competition and aggressive acquisition of new clients through high deposit rates and (iii) the lack of adequate regulation. In this part, we aim to estimate the impact of increasing market rates on banks (for our scenarios see Table 3.3) in relation to savings accounts using our modified replicating portfolio approach defined in the section 2.4.2. The outcome of our analysis is the cumulative net interest income from the reinvestment of savings accounts not only on the market, but also into consumer loans and mortgages. Additionally, for the *low-cost bank*, we define two types of portfolios: non-aggressive and

aggressive. Aggressive portfolio shows that riskier investment of savings accounts results in positive net interest income even under a relatively high deposit rate, but at the cost of risky position in high-yield instruments such as corporate bonds.

Table 3.3: Market rate scenarios

Scenarios	Final value of the market rate	Duration to the final value in months
Scenario 1	0.05%	24
Scenario 4	0.05%	60
Scenario 2	2%	24
Scenario 5	2%	60
Scenario 3	5%	24
Scenario 6	5%	60

Source: Authors

For better transparency, we divide results into two groups: (i) the net cumulative interest income of the bank and (ii) the impact on the capital of the bank. First, Figure 3.2 and Figure 3.3 show the cumulative net interest income a bank is able to generate from savings accounts deposits in retail for each out of six scenarios. Evidently, the *low-cost bank* is able to generate positive cumulative net interest income that would cover a high deposit rate only for the aggressive reinvestment strategy under Scenarios 1, 4, 5, and 6 while Scenarios 1, 2, 3 and 5 for the conservative portfolio of the *low-cost bank* generate negative interest rate income in the observed periods and Scenarios 4 and 6 very low positive interest income. We raise the question whether such an aggressive strategy is consistent with sound risk management of savings accounts, however. On the contrary, both *the well-established bank* and *the third type* generate positive net interest income from savings accounts in all scenarios. This shows, as we assumed, that the reinvestment of savings accounts that starts during low market rates can provide feasible income under two conditions: (i) a bank has to reinvest a substantial part of liabilities into riskier instruments, such as consumer loans and mortgages (market reinvestment is not sufficient), and (ii) a bank must offer sustainable deposit rate that is in accordance with the market.

Figure 3.2: Cumulative net interest income for Scenarios 1-3

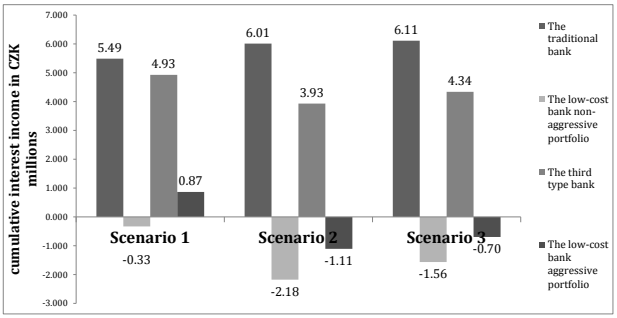
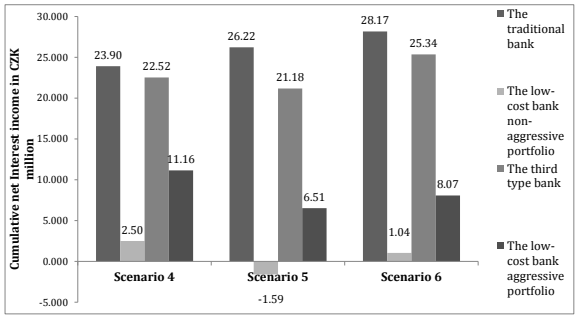


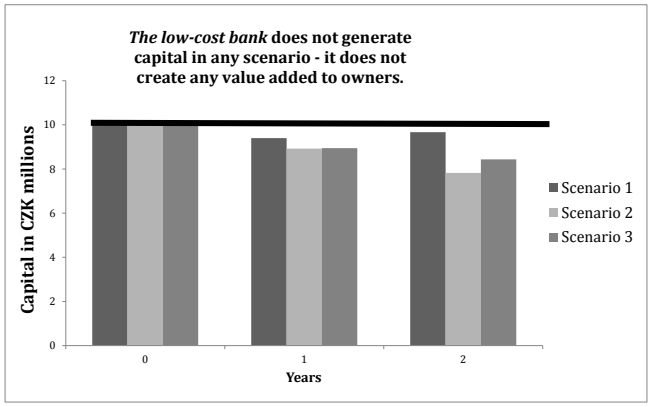
Figure 3.3: Cumulative net interest income for Scenarios 4-6



Source: Authors

In banks with common zero-fee policies, the net interest rate loss from savings accounts would have to be absorbed directly by their capital. Hence, we analyzed the impact of the net interest rate loss on the capital. We assume that initial value of the capital is CZK 10 million, what corresponds to 10% capital adequacy. For simplicity, we exclude all other costs and revenues such as taxes, obligatory deposit insurance or charged fees. Figure 3.4 shows the impact on the capital of the non-aggressive strategy for 2-year scenarios). Evidently, the capital decreases in all scenarios. Particularly it decreases by 22% in Scenario 2 and by 16% in Scenario 3. Therefore, we find that a quick increase in the market rates to 5% in Scenario 3 leads to slightly lower loss than an increase to 2% in Scenario 2. This is a result of increasing consumer loans´ interest rates and yields on bonds as these increase more in Scenario 3, which partially compensates for the high deposit rates. We conclude that under increasing market rates, some banks in the Czech Republic might lose up to 22% of capital within two years under the most severe scenario.

Figure 3.4: The impact on capital



Source: Authors

We find that rapidly increasing market rates after a prolonged period of low market rates are a crucial factor for bank´s profitability from savings accounts. This result is in line with International Monetary Fund (2013) and Bank of England (2013). We show that potential losses stemming from the portfolio of long-term low yield assets[6] are substantial for a banks with business model built upon a high deposit rate bearing savings accounts in order to attract new clients. We also show that savings accounts, even when hedged properly, are riskier liabilities than current accounts only because they are more costly and require a higher yield reinvestment, which is obviously connected with higher risk. Adding competitive pressures, we conclude that savings accounts are indeed riskier instruments in banks´ balance sheets than current accounts and term deposits.

Second, Maes and Timmermans (2005) stress that savings deposits raise stability issues in Belgium due to difficult risk mitigation stemming from embedded options. We provide evidence that savings accounts are risky liabilities in the Czech Republic for banks where savings accounts represent a main source of funding. As the importance of savings accounts in the Czech banking sector increases, so may increase potential stability issue stemming from unsound interest rate risk management of savings accounts.

Third, we argue that we find sufficient evidence that savings accounts are risky instruments in banks´ balance sheet and the banks relying on this type of funding are obviously risky. We doubt that a business model of some banks that enables financing risky activities (e.g. consumer loans in Asia through securitization techniques) from savings accounts is prudent pursuant to §12 from Act No. 21/1992 Coll. of 20 December 1991, on banks that reads:

""A bank or a branch of a bank from a non-Member State shall carry on its activities with prudence and, in particular, pursue its business in a manner which is not detrimental to the interest of its depositors in respect of the recoverability of their deposits and ***which does not endanger the bank´s safety and soundness.***

A bank of a branch of a bank from a non-Member State may not conclude any agreements ***under conditions which are conspicuously disadvantageous for a bank or a branch of a bank*** *from a non-Member State, especially such that bind it to economically unjustified*

[6] When savings accounts are repriced more quickly, what results from both maturity and duration mismatch.

performance or performance ***that fails conspicuously to correspond to the countervalue provided****. Agreements concluded in contravention of this provision shall be invalid."*

Put differently, we believe that the banks funded from savings accounts are not prudent pursuant to the Act on banks and import systemic risk from abroad to the Czech banking sector. It is common knowledge that banks are global in life in death. As a result, these risky banks shall be monitored very carefully by the Czech National Bank, which should ask for them for higher capital requirements of these banks of for their higher contribution to the Deposit Insurance Fund.

4 Conclusion

This paper dealt with the risk management of savings accounts defined as non-maturing accounts bearing a relatively attractive rate of return. We highlight two embedded options of savings accounts: a customer's option to withdraw money at any time and a bank's option to set the deposit rate freely. As a result, the risk management of saving accounts remains an art as well as a science and simultaneously raises serious concerns by some regulators (especially in Belgium, where these instruments form a significant part of bank liabilities). We presented six key savings accounts risks: liquidity risk, systemic risk, reputational risk, model risk, concentration risk and market risk (including interest rate risk).

We primarily focused on interest rate risk management of savings accounts in the Czech Republic and provided evidence that many high deposit rates offered on savings accounts have not been in accordance with sound pricing recently. We argue that in order to attain high deposit rates, banks will have to either opt for risky reinvestments or to increase its capital to cover the net interest rate loss from the reinvestment of savings accounts, especially when market rates increase.

As savings accounts are regulated instruments in Belgium. Austria, Germany and France, we propose their stricter regulation including variable caps on deposit rates or longer notice periods on withdrawals that exceed a certain amount. Such stricter regulation would also discourage other banks that do not offer "attractive" savings accounts. Another possibility is

to focus on the moral hazard behind savings accounts. Clients' deposit their savings on a high deposit rate bearing savings accounts without taking into the account the risk as all deposits are, by law, insured as all banks are required to pay 16 bps per annum to the Deposit Insurance Fund. Should savings accounts be excluded from the obligatory insurance scheme, many risk-averse clients would rather place their funds into less riskier instruments. This would address the clients´ moral hazard problem. On the other hand, it might lead some banks to increase the client rate even more. The other solution would be to have more levels of an obligatory deposit insurance cost, for example 16 bps per annum for a bank with the client rate below market average and 32 bps for a bank above this average. Naturally, a higher deposit insurance cost would decrease the profitability of the product, which would push banks to decrease the client rate. Last but not least, the regulator should be able to assess a degree to which individual banks are exposed to savings accounts' risks. Maes and Timmermans (2005) point out the need of unified models used for modeling of savings accounts. A unified approach would enable the regulator to compare risk management of savings accounts in different banks.

Concerning further research opportunities, these are numerous. First, liquidity risk is a center of regulator's attention these days and should be addressed accordingly by future research. Particularly, European Banking Authority (2013) focuses on the definition of stable deposits and aims to distinguish between stable and non-stable deposits. Second, our further research may assess the level of stability of retail savings accounts and whether it is significantly different from other demand deposits, particularly current accounts or corporate demand deposits. Finally, reputational risk can also be tested when assuming deterioration in bank´s brand followed by outflows of bank's deposits or followed even by bank runs.

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