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OPTIMAL DEPOSIT AND LOAN INTEREST RATES SETTING IN CO-OPERATIVE BANKS

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Abstract. This paper tries to solve theoretically the problem of interest rate determination by a co-operative bank in the absence of preferential treatment of its members (owners) against non-members in terms of charged interest rates. The optimisation model considers bank's borrower-, depositor- and neutral-oriented policy as well as purely commercial (profit-oriented) approach. Obtained results indicate that the optimal rates on loans and deposits at a co-operative bank depend mainly on its preference. They are also influenced by market interest rates and bank's balance sheet and income statement elements. The paper contributes to an increased understanding of behaviour of co-operative bank as social economy organisation and adds to the models of optimal interest rates setting in co-operative financial institutions.

Key words: co-operative bank, social economy, optimal interest rates, deposits, loans

INTRODUCTION

Haberler [1937] claims that "The theory of interest has for a long time been a weak spot in the science of economics, and the explanation and the determination of the interest rate still gives rise to more disagreement amongst economists than any other branch of general economic theory". In other words, there is no commonly accepted theory of how an interest rate is determined. Prominent loanable funds theory runs in terms of demand for capital (credits) and supply of savings which both determine interest rates. Taking co-operative bank (CB) as the study object, its members are both demanders for and suppliers of loanable funds and their bank intermediates between them as savers (depositors) and borrowers.

The supporters of monetary theories seek in the theory of interest the problem of value, omitting that of the distribution of welfare gains between lenders and borrowers.

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n out paper, interest rate theory is viewed from the standpoint of social responsibility of CBs which should lie at the heart of the co-operative approach to business.

Several studies have broadly discussed the role of CBs in mobilizing local savings and expanding credit access to households, farmers and SMEs. The bulk of research dealing with interest rate setting by co-operative (not-for-profit) financial entitles addresses mainly credit unions. The most influential contributions include those by: Taylor [1971], Flannery [1974], Brockschmidt [1977], Walker and Chandler [1977], Baltensperger [1980], Murray and White [1980], Black and Dugger [1981], Smith [1981, 1986], Fry et al. [1982], Patin and McNiel [1991], Feinberg and Rahman [2001], Leggett and Strand [2002], McKillop and Wilson [2011], Wheelock and Wilson [2013], and Bressan et al. [2013]. Similar publications on CBs, largely present in the EU and Poland's economies, are to our knowledge rare. In Europe, a model of banking firm was applied by Kasman et al. [2010] who analysed the determinants of net interest margin in the banking systems of EU member and candidate countries.

Theoretical modelling of interest rate behaviour in CB enables to explain formally the nature of cooperative banking idea. In such approach neither typical features of commercial banks nor those of traditional co-operatives can be adopted, at least for two reasons. Firstly, contrary to credit union, not all CB's customers are its members. Secondly, unlike for commercial bank (usually joint-stock company), the profit maximization is not a prime goal of CB's owner-member. Rather, his/her purpose is to exploit own benefits (welfare) from bank's membership. This does not imply, obviously, that CB as a firm is not concerned about profit generation which is related with its solvency and economic survival.

CB's members may be either borrowers (net borrowers) or savers (net savers) with CB. Borrowers prefer reduced loan interest rates while savers – higher deposit rates. The dilemma, then, is how to deal with the actual or potential conflict between them about the benefits distribution. Successful management of interest rates by CB needs balancing the expectations of those both groups. While commercial bank performance is determined by adequate management of the relationship between risk and profitability [Kutan et al. 2012], CB's activity should be guided by adequate management of the relationship between social and business goals. The primary aim of CBs is to raise their members' welfare, so profits are supposed only to serve as means of achieving a broader range of activities. Thus, the models for commercial banks are wholly inadequate to describe CBs, while those for credit unions cannot be generalized to CBs.

With the aim to contribute to the theoretical literature on interest rate determination by CB, this paper, based on the previous studies and Poland's practice, proposes formal model in which CB's customers (members and non-members) are treated equally with respect to interest rates on loans and deposits. The paper is structured as follows. The next section presents a brief description of the CBs in the EU and Poland. Then, the model specification is given. Next, we seek for the optimal interest rates on loans and deposits under a CB's four preference approaches. Finally, the summary and conclusions are provided.

THE EUROPEAN CO-OPERATIVE BANKS

In Europe in 2013 there were 4,000 CBs which operated via 71,000 branches, served 217 million customers and had 56 million members [EACB 2014]. European co-operative banking sector was relatively resistant to the financial crisis of 2007–2009 with only 8% of losses of the entire banking sector [Prieg and Greenham 2012].

In Poland, CBs are numerous but smaller by assets than their commercial counterparts – mostly controlled by foreign investors. In 2014 there were 566 CBs with 4,230 branches. Their number has been steadily shrinking, mainly since 1995, as a result of restructuring process aimed at raising banks' sizes and thus making them more competitive and resilient [Zawojska and Siudek 2005]. Polish CBs serve around 10 million customers, tenfold more than members (1.021 million in 2014) they have. Unfortunately, there is decreasing trend in number of CB's members. A positive fact is that Polish CBs gradually strengthen their position in loan and deposit market. In 2014, their share of entire banking sector was 10% for loans and 8% for deposits held by non-financial entities [KNF 2014]. In the EU, CBs account for about 20% of the bank deposits and loans.

As bank membership is limited to Poland's residents (natural and legal persons), CB's capital is purely domestic in origin. Foreign exchange operations require permission from affiliating bank, so CBs typically do not offer deposits and loans in foreign currencies. Polish CBs are not allowed to participate in interbank market except for transactions with their affiliating bank; their lending is principally funded by local deposit base and, eventually, by loans from affiliating bank. Just like in other countries, formally declared mission of Polish CBs is to support their members and contribute to local (rural) socio-economic development. In practice, however, there is potential conflict between meeting demands of members and focusing on profit (the latter induced by competition and regulatory pressures, e.g. solvency regulations). In Poland, real benefits from the membership in CB seem to be small. Even though members are formally entitled to profit distribution via dividend related to subscribed stakes, dividends actually paid by CBs are rather scarce and, if any, of symbolic amounts. According to Financial Supervision Authority – FSA [2013], in 2009 only 5% of year-end profit was distributed this way and the fraction was expected to shrink to 1.8% in 2013. Moreover, in line with the recent FSA's recommendation on maintaining strong capital base, CBs should not pay out dividends but use their profits to increase capital levels. Besides, Polish CBs do not offer any patronage dividend related to the value/volume of bank services used by members and do not give them any preferences, as compared with non-members, in the pricing of deposits and loans[1].

Although the co-operative traditions, legislation and some features of CBs differ between European countries [Siudek 2011, Martín and Marqués Sevillano 2011], there is common element for whole European co-operative banking sector – the democratic nature of CBs. Owners shape bank policy by voting rights based on the Rochdale principle "one member, one vote", i.e. rights not proportional to size of member's stake in CB. This principle should (at least theoretically) encourage all bank members to take an equal concern in bank management.

[1]In Poland, preferential treatment of CB's members in terms of interest rates constitutes the infringement of Article 79 of the Banking Law Act [Journal of Laws, No 140, Item 939].

THE SPECIFICATION OF FORMAL BEHAVIOURAL MODEL

The proposed model for CB is expected to meet two basic requirements. Firstly, an objective function should reflect the optimization of bank members' benefits arising from transactions with CB (i.e. maximization of their loans and deposits at, respectively, the lowest and highest interest rates). Secondly, within the membership group, borrowers and savers should be treated equally, i.e. without any discrimination. Basing on the reality of Polish CB, the model assumes that its member and non-member customers are treated similarly with respect to loan and deposit interest rates. The model seeks maximum financial gains for borrowers and savers (Equation 1).

Borrowers' gains from loans (*GL*) are defined as the total amount of their loans with CB multiply by a gap between the lowest available market loan interest rate (r_{LM}) and loan interest rate in CB (r_L). Gains on savings (*GS*) are defined as savers' deposits with CB multiply by a gap between interest rate on deposits in CB (r_S) and the highest obtainable market deposit interest rate (r_{SM}). Other benefits from the membership may stem from dividends and CB's societal services, like educational or cultural events, for example. The gains for borrowers and savers are weighted by CB's preference coefficients (γ and σ) reflecting the strength of its orientation towards borrowers (with $\gamma = 1$; $\sigma = 0$ denoting full borrower preference) and savers (with $\gamma = 0$; $\sigma = 1$ denoting full depositor preference). The general objective function is specified in Equation 4.

The ratio of loans repayment is given by φ, while deposits payment – by ω. Amount loaned by CB is then as follows: L in the first year; $(1 - \varphi)\, L$ in the second, and $(1 - \varphi)^n L$ in the n-th year. Correspondingly, the value of deposits raised by CB is: S in the first year; $(1 - \omega)$ S in the second, and $(1 - \omega)^n$ S in the n-th year. After discounting the gains, Equations 9 and 10 are obtained. It is assumed that CB applies a declining balance (geometric) method for loan repayments and deposit payouts. *GL* and *GS* are discounted (Equation 4) using the geometric series summation formula:

$$\frac{1+d}{d+\varphi} \text{ and } \frac{1+d}{d+\omega}$$

Provision of loans by CB depends on interest rates r_{LM} and r_L. If gap between them widens (narrows), the value of loans increases (decreases). Consequently, increase/decrease in $(r_S - r_{SM})$ results in rise/fall of deposits in CB.

Objective function of co-operative bank (general specification):

$$\max f(r_L, r_S) = \gamma\, GL + \sigma\, GS + \pi; \quad \pi \geq 0;\ \gamma = \langle 0;\ 1 \rangle;\ \sigma = \langle 0;\ 1 \rangle \tag{1}$$

Benefits for the *j*-borrower in co-operative bank:

$$GL^j = (r_{LM} - r^j{}_L)\, L^j; \quad r_{LM} > r^j{}_L \tag{2}$$

Benefits for the *j*-saver in co-operative bank:

$$GS^j = (r^j{}_S - r_{SM})\, S^j; \quad r^j{}_S > r_{SM} \tag{3}$$

where: *j* – CB's customer (member or non-member);

rL – interest rate on loans granted by CB its customers;

r_S – interest rate on deposits paid into CB by its customers;
r_{LM} – the best alternatively available (for CB customers) market loan interest rate;
r_{SM} – the best alternatively available (for CB) market deposit interest rate;
L – value of loans made by CB to its customers;
S – value of deposits made with CB by its customers;
γ – coefficient stating the degree of CB's preference towards borrowers;
σ – coefficient stating the degree of CB's preference towards depositors;
GL – gains for borrowers from CB;
GS – gains for savers in CB;
π – financial surplus of CB used to subsidy interest rates on customers' loans and deposits.

Objective function of cooperative bank (extended specification):

$$\max f(r_L, r_S) = \gamma \frac{1+d}{1+\varphi}(r_{LM} - r_L) \times L + \sigma \frac{1+d}{d+\omega}(r_S - r_{SM}) \times S + \pi$$

$\pi \geq 0$; $\gamma = \langle 0; 1 \rangle$; $\sigma = \langle 0; 1 \rangle$

where: d – discount rate;
φ – repaid loans as a percentage of total loans made by CB in a given period;
ω – paid-out deposits as a percentage of total deposits with CB in a given period.

$$GL\sum_{j=1}^{j}(r_{LM} - r_L^j)L^j \text{ – total benefits for co-operative bank borrowers} \quad (5)$$

$$GS\sum_{j=1}^{j}(r_M^j - r_{SM})S^j \text{ – total benefits for co-operative bank savers} \quad (6)$$

where: r^j_L – interest rate on loans granted by CB to the j-th customer;
r^j_S – interest rate on deposits taken by CB from the j-th customer;
L^j – amount of the loan granted to the j-th customer;
S^j – amount of the savings (deposits) of the j-th customer.

The dependence of amount loaned by co-operative bank on interest rates r_{LM} and r_L:

$$\sum_{j=1}^{j} L^j = L\,(r_{LM}, r_L), \quad \frac{\partial L}{\partial r_{LM}} > 0; \quad \frac{\partial L}{\partial r_L} < 0 \quad (7)$$

The dependence of amount deposited in co-operative bank on interest rates r_{SM} and r_S:

$$\sum_{j=1}^{j} S^j = S\,(r_{SM}, r_S), \quad \frac{\partial S}{\partial r_{SM}} < 0; \quad \frac{\partial S}{\partial r_S} > 0 \quad (8)$$

Borrowers' gains – extended formula:

$$GL = (r_{LM} - r_L)L + \frac{(r_{LM} - r_L)(1-\varphi)L}{1+d} + \frac{(r_{LM} - r_L)(1-\varphi)^2 L}{(1+d)^2} + \ldots \quad (9)$$

Savers' gains – extended formula:

$$GS = (r_S - r_{SM})S + \frac{(r_S - r_{SM})(1-\omega)S}{1+d} + \frac{(r_S - r_{SM})(1-\omega)^2}{(1+d)^2} + \ldots \quad (10)$$

To simplify, it is assumed that both customers' loan demand and savings supply are linear functions of interest rate gap. Thus, Equation 15 gives the effect of difference between market interest rate (r_{LM}) and that charged by CB (r_L) on demand for loans. Equation 16 shows how supply of savings depends upon the margin between r_S and r_{SM}. CB's opening and closing balance sheets (Equations 11 and 12) are constraints on the function maximizing gains.

An opening balance sheet of co-operative bank:

$$AT_0 + I_0 + (1 - \varphi)\, L_0 = (1 - \omega)\, S_0 + KW_0 + R_0 + U_0 \quad (11)$$

A closing balance sheet of co-operative bank:

$$AT_0 + AT + I_0 + I + (1 - \varphi)\, L_0 + L = (1 - \omega)\, S_0 + S + KW_0 + KW + R_0 + R + U_1 \quad (12)$$

where: AT_0 – value of fixed assets in CB at the beginning of the reporting year;
AT – increase/decrease in value of CB's fixed assets during the reporting year;
I_0 – value of CB's claims (liabilities) in financial market at the beginning of reporting year;
I – increase/decrease in CB's claims (liabilities) in financial market during reporting year;
L_0 – value of loans granted by CB to customers at the start of the reporting year;
L – value of loans granted by CB to customers during the reporting year;
S_0 – value of customers' savings in CB at the beginning of the reporting year;
S – value of customers' savings in CB during the reporting year;
KW_0 – value of own funds of CB at the beginning of the reporting year;
KW – increment in value of CB own funds during the reporting year;
R_0 – value of CB provisions at the beginning of the reporting year;
R – increase/decrease in CB provisions during the reporting year;
U_0 – profit of CB remaining from a previous period, currently distributed for dividend payment to bank members, own funds, subsidising interest rates on customers' loans and savings;
U_1 – profit of CB retained to be paid out as dividends, to increase own funds, to subsidise interest rates on customers' loans and savings in the next reporting year.

The value of customers' loans and savings in pre- and reporting periods is shown in Equations from 13 to 16. The excess of deposits over loans is located by CB on financial market (Equation 19). Equation 21 presents CB's operating costs while Equation 22 – net

provisions. Bank's financial surplus (Equations 23 and 24) was computed considering not only standard costs and revenues but also costs of social services (K_{un}) provided to members (local community) and retained profit (U_1). The latter, in the next period may contribute to CB's own capital, be partially paid out as dividend or used to subsidize interest rates on loans (to reduce their level) and deposits (to raise their level). The current financial surplus can be enlarged with retained profit from a prior period (U_0) subtracted by paid dividends and accumulated capital.

Demand for loans in CB as a function of interest rates (r_{LM0}; r_{L0}) – pre-reporting year:

$$L_0 = \alpha_0 (r_{LM0} - r_{L0}); \quad \alpha_0 > 0; r_{LM0} > r_{L0} \tag{13}$$

Supply of savings in CB as a function of interest rates (r_{S0}; r_{SM0}) – pre-reporting year:

$$S_0 = \beta_0 (r_{S0} - r_{SM0}); \quad \beta_0 > 0; r_{S0} > r_{SM0} \tag{14}$$

Demand for loans in CB as a function of interest rates (r_{LM}; r_L) – reporting year:

$$L = \alpha (r_{LM} - r_L); \quad \alpha > 0; r_{LM} > r_L \tag{15}$$

Supply of savings in CB as a function of interest rates (r_S; r_{SM}) – reporting year:

$$S = \beta (r_S - r_{SM}); \quad \beta > 0; r_S > r_{SM} \tag{16}$$

Value of financial investments by CB in pre-reporting year:

$$I_0 = (1 - \omega) S_0 - (1 - \varphi) L_0 \quad \text{– general formula} \tag{17}$$

$$I_0 = (1 - \omega) \beta_0 (r_{S0} - r_{SM0}) - (1 - \varphi) \alpha_0 (r_{LM0} - r_{L0}) \quad \text{– extended formula} \tag{18}$$

Value of financial investments by CB in reporting year:

$$I = S - L \quad \text{– general formula} \tag{19}$$

$$I = \beta (r_S - r_{SM}) + \alpha (r_{LM} - r_L) \quad \text{– extended formula} \tag{20}$$

Total operating costs in a CB in reporting year:

$$K_{dz} = C_{L0} L_0 + C_{S0} S_0 + C_L L + C_S S \tag{21}$$

Net provisions in a CB in reporting year:

$$P_{rez} - K_{rez} = \rho_0 L_0 + \rho L = \rho_0 \alpha_0 (r_{LM0} - r_{L0}) + \rho \alpha (r_{LM} - r_L) \tag{22}$$

Financial surplus in a CB – general formula:

$$\begin{aligned} \pi = {} & (1 - \varphi) L_0 \times r_{L0} + L \times r_L - (1 - \omega) S_0 \times r_{S0} - S \times r_S + P_{pr} - K_{pr} + \\ & + I_0 \times r_{IM0} + I \times r_{IM} + P_{RK} - K_{RK} + P_{op} - K_{op} + P_{rez} - K_{rez} - K_{dz} - K_A + \\ & + Z_n - S_n - P_{cit} - K_{un} - U_1 + U_0 (1 - \mu) \end{aligned} \tag{23}$$

Financial surplus in a CB – extended formula:

$$\begin{aligned} \pi = {} & \alpha (r_{LM} - r_L) \times r_L - \beta (r_S - r_{SM}) \times r_S + [\beta (r_S - r_{SM}) - \alpha (r_{LM} - r_L)] \times \\ & \times r_{IM} - \alpha C_L (r_{LM} - r_L) - \beta C_S (r_S - r_{SM}) - \rho \alpha (r_{LM} - r_L) + RFS \end{aligned} \tag{24}$$

Residual financial surplus (RFS) is obtained as:

$$RFS = (1-\varphi)\,\alpha_0\,(r_{LM0} - r_{L0}) \times r_{L0} - (1-\omega)\,\beta_0\,(r_{S0} - r_{SM0}) \times r_{S0} +$$
$$+ [(1-\omega)\,\beta_0\,(r_{S0} - r_{SM0}) - (1-\varphi)\,\alpha_0\,(r_{LM0} - r_{L0})] \times r_{IM0} + [\beta\,(r_S - r_{SM}) -$$
$$- \alpha\,(r_{LM} - r_L)] \times r_{IM} - (1-\varphi)\,\alpha_0\,C_{L0}\,(r_{LM0} - r_{L0}) - (1-\omega)\,\beta_0\,C_{S0}\,(r_{S0} - r_{SM0}) -$$
$$- \rho_0\,\alpha_0\,(r_{LM0} - r_{L0}) - \rho\,\alpha\,(r_{LM} - r_L) + P_{pr} - K_{pr} + P_{RK} - K_{RK} + P_{op} - K_{op} - K_A +$$
$$+ Z_n - S_n - P_{cit} - K_{un} - U_1 + U_0\,(1-\mu) \qquad (25)$$

where: π – CB's financial surplus used to subsidise interest rates on loans and deposits in reporting year;
r_{L0} – interest rate on customers loans in CB in pre-reporting year;
r_L – interest rate on customers' loans in CB in reporting year;
r_{S0} – interest rate on customers' savings in CB in pre-reporting year;
r_S – interest rate on customers' savings in CB in reporting year;
P_{pr} – CB's revenue from commission charges in the reporting year;
K_{pr} – CB's commission expenses in the reporting year;
r_{IM0} – interest rate on CB's investments/liabilities on financial market in pre-reporting year;
r_{IM}[2] – interest rate on CB's investments/liabilities on financial market in reporting year;
ρ_0 – total net provisions (= those established for credit exposures minus released provisions) as a share of total amount loaned by CB to its customers in pre-reporting year;
ρ – total net provisions as a share of total amount loaned by CB to customers in reporting year;
P_{RK} – income from positive foreign exchange rate changes in reporting year;
K_{RK} – costs of negative foreign exchange rate changes in reporting year;
P_{op} – remaining operating revenues in reporting year;
K_{op} – remaining operating costs in reporting year;
P_{rez} – revenues from released provisions in reporting year;
K_{rez} – costs of establishing provisions in reporting year;
K_{dz} – operating costs in reporting year;
C_{L0} – unit loan servicing costs in pre-reporting year;
C_{S0} – unit deposit servicing costs in pre-reporting year;
C_L – unit loan servicing costs in reporting year;
C_S – unit deposit servicing costs in reporting year;
K_A – depreciation costs in reporting year;
Z_n – extraordinary profits in the reporting year;
S_n – extraordinary losses in the reporting year;
P_{cit} – corporate income tax (CIT);
K_{un} – costs of social services provided by CB for its members/local community,
U_0 – retained profit from previous year;
μ – fraction of retained profit from previous year used to pay dividends and raise own funds;
U_1 – profit retained by CB to pay out dividends, raise own funds and subsidy interest rates on customers' loans and deposits in the next reporting year.

[2]CB may locate its surplus funds in short-term securities or time deposits in affiliating bank, and respectively borrow financial funds exclusively from this bank.

OPTIMAL LOAN AND DEPOSIT INTEREST RATES IN A CO-OPERATIVE BANK

The study considers four possible approaches undertaken by CB: the complete borrower preference (Equation 49); the neutrality (Equation 50), the complete saver preference (Equation 51) and the purely commercial (business) orientation (Equation 52).

Under commercial approach which seeks profit maximisation, the objective function $f(r_L, r_S)$ value equals to financial surplus (π). After solving the first order condition, we obtain either loan interest rate (r_L) (Equation 26) or deposit interest rate (r_S) (Equation 27) used to solve the problem of financial surplus maximization (Equations 28 and 29).

Formula for calculating an optimal loan interest rate (r^*_L) – complete commercial approach:

$$r^*_L = \frac{r_{LM} + r_{IM} + C_L + \rho}{2} \tag{26}$$

Formula for an optimal deposit interest rate (r^*_S) – complete commercial approach:

$$r^*_S = \frac{r_{SM} + r_{IM} + C_S}{2} \tag{27}$$

Maximum financial surplus in business-oriented CB – general formula:

$$\pi^* = \frac{\alpha(r_{LM} - r_{IM} - C_L - \rho)^2 + \beta(r_{IM} - r_{SM} - C_S)^2}{4} + RFS \tag{28}$$

Maximum financial surplus in business-oriented CB – extended formula:

$$\begin{aligned} \pi^* = {} & \frac{(1-\varphi)\alpha 0(r_{LM0} - r_{iM0} - C_{L0} - \rho_0)^2 + (1-\omega)\beta 0(r_{IM0} - r_{SM0} - C_{S0})_2}{4} + \\ & + \frac{\alpha(r_{LM} - r_{IM} - C_L - \rho)^2 + \beta(r_{IM} - r_{SM} - C_S)^2}{4} + P_{pr} - K_{pr} + P_{RK} - K_{RK} + \\ & + P_{op} - K_{op} - K_A + Z_n - S_n - P_{cit} - K_{un} - U_1 + U_0(1-\mu) \end{aligned} \tag{29}$$

When CB is completely commercial-oriented, interest rate on customer loans depends on: the best market loan interest rate (r_{LM}); interest rate on CB's investments/liabilities on financial market (r_{IM}); unit cost of loan servicing (C_L) and the total net provisions (ρ). Deposit interest rate is affected by: the best market deposit interest rate (r_{SM}); CB's return on financial market (r_{IM}) and unit cost of deposit service (C_S). Rates r_{LM}, r_{SM}, and r_{IM} are external, while C_L, C_S and ρ depend mainly on CB's policy. For other scenarios optimal loan interest rates (r_L) are given by Equations 30, 32 and 34 while optimal deposit interest rates (r_S) by Equations 31, 33 and 35.

Formula for calculating an optimal loan interest rate (r^*_L) – complete borrower preference:

$$r*_L = \frac{r_{LM} + r_{IM} + C_L + \rho}{2} - \frac{r_{LM} - r_{IM} - C_L - \rho}{2} \times \times \left[1 + \frac{\beta(r_{IM} - r_{SM} - C_s)^2 - 4RFS}{\alpha(r_{LM} - r_{IM} - C_L - \rho)^2} \right]^{1/2} \quad (30)$$

Formula for calculating an optimal deposit interest rate ($r*_S$) – complete borrower preference:

$$r*_S = \frac{r_{SM} + r_{IM} - C_S}{2} \quad (31)$$

Formula for calculating an optimal loan interest rate ($r*_L$) – complete saver preference:

$$r*_L = \frac{(r_{LM} + r_{IM} + C_L + \rho}{2} \quad (32)$$

Formula for calculating the optimal deposit interest rate ($r*_S$) – complete saver preference:

$$r*_S = \frac{r_{SM} + r_{IM} - C_S}{2} + \frac{r_{IM} - r_{SM} - C_S}{2} \times \times \left[1 + \frac{\alpha(r_{LM} - r_{IM} - C_L - \rho)^2 - 4RFS}{\beta(r_{IM} - r_{SM} - C_S)^2} \right]^{1/2} \quad (33)$$

Formula for calculating an optimal loan interest rate ($r*_L$) – the neutral approach:

$$r*_L = \frac{r_{LM} + r_{IM} + C_L + \rho}{2} - \frac{r_{LM} - r_{IM} - C_L - \rho}{2} \times \times \left[1 - \frac{4RFS}{\alpha(r_{LM} - r_{IM} - C_L - \rho)^2 + (r_{IM} - r_{SM} - C_S)^2} \right]^{1/2} \quad (34)$$

Formula for calculating an optimal deposit interest rate ($r*_S$) – the neutral approach:

$$r*_S = \frac{rIM + rSM - CS}{2} + \frac{rIM - rSM - CS}{2} \times \times \left[1 - \frac{4RFS}{\alpha(r_{LM} - r_{IM} - C_L - \rho)^2 + \beta(r_{IM} - r_{SM} - C_S)^2} \right]^{1/2} \quad (35)$$

During the modelling process, optimal interest rates ($r*_L$, $r*_S$) are obtained by using general set of Equations (36–38) and the Lagrange multiplier (λ). Financial surplus equal to zero acts as a constraint since its total amount is believed to be used for subsidising interest rates on loans and deposits. Equations 36 and 37 express differentiation of

the objective function with respect to interest rates while Equations 39–41 represent an extended formula for estimation of optimal rates. Additional assumptions are given by Equations 42–45. The second-order behaviour of the objective function is expressed in Equation 46.

An equation set (36–38) for estimating optimal rates (r^*_L, r^*_S) – general formula:
The first-order derivative of objective function with respect to interest rate r_L:

$$\lambda \frac{1+d}{d+\varphi}\left[(r_{LM}-r_L)\frac{\partial L}{\partial rL}-L\right]+\lambda\frac{\partial \pi}{\partial r_L}=0 \tag{36}$$

The first-order derivative of the objective function with respect to interest rate r_S:

$$\sigma \frac{1+d}{d+\omega}\left[(r_S-r_{SM})\frac{\partial S}{\partial r_S}+S\right]+\lambda\frac{\partial \pi}{r_S}=0 \tag{37}$$

Assumption that CB's financial surplus equals

$$\pi = 0 \tag{38}$$

An equation set (39–41) for calculating optimal interest rates – extended formula:
The first-order derivative of objective function in respect to interest rate r_L:

$$\gamma \frac{1+d}{d+\varphi}[-2\alpha(r_{LM}-r_L)]+\lambda\alpha(r_{LM}-2_{rL}+r_{IM}+C_L+\rho)=0 \tag{39}$$

The first-order derivative of objective function in respect to interest rate r_S:

$$\sigma \frac{1+d}{d+\omega}[2\beta(r_S-r_{SM})]+\lambda\beta(r_{SM}-2_{rS}+r_{IM}-C_S)=0 \tag{40}$$

Assumption that CB's financial surplus equals

$$\pi = 0 \tag{41}$$

An increment in the surplus π against loan interest rate (r_L) in CB (the first-order derivative of the function π in respect to the variable r_L) – general formula:

$$\frac{\partial \pi}{\partial r_L}=\frac{\partial L}{\partial r_L}r_L+L>0 \tag{42}$$

An increment in the surplus π against deposit interest rate (r_S) in CB (the first-order derivative of the function π in respect to the variable r_S) – general formula:

$$\frac{\partial \pi}{\partial r_S}=-\frac{\partial S}{\partial r_S}r_S-S<0 \tag{43}$$

An increment in the surplus π against loan interest rate (r_L) in CB (the first-order derivative of the function π in respect to the variable r_L) – extended formula:

$$\frac{\partial \pi}{\partial r_L} = \alpha(-2r_L + r_{LM} + r_{IM} + C_L + \rho) > 0 \tag{44}$$

An increment in the surplus π against deposit interest rate (r_S) in a co-operative bank (the first-order derivative of the function π in respect to the variable r_S) – extended formula:

$$\frac{\partial \pi}{\partial r_S} = \beta(-2r_{Scz} + r_{SM} + r_{IM} - C_S) < 0 \tag{45}$$

The determinant of the symmetric Hessian matrix used to indicate the response of interest rates r_L and r_S to balance-sheet variables and profit and loss account in co-operative bank:

$$|\Delta| = \begin{vmatrix} \Delta_{11} & 0 & \frac{\partial \pi}{\partial r_L} \\ 0 & \Delta_{22} & \frac{\partial \pi}{\partial r_S} \\ \frac{\partial \pi}{\partial r_L} & \frac{\partial \pi}{\partial r_S} & = \end{vmatrix} = -\left[\frac{\partial \pi}{\partial r_S}\right]^2 \Delta_{11} - \left[\frac{\partial \pi}{\partial r_L}\right]^2 \Delta_{22} > 0 \tag{46}$$

The second derivative of objective function with respect to loan interest rate (r_L):

$$\Delta_{11} = \gamma \frac{1+d}{d+\varphi}\left[(r_{LM} - r_L)\frac{\partial^2 L}{\partial r^2 L} - 2\frac{\partial L}{\partial r_L}\right] + \lambda \frac{\partial_2 \pi}{\partial r^2{}_L} \tag{47}$$

The second derivative of objective function with respect to deposit interest rate (r_S):

$$\Delta_{22} = \sigma \frac{1+d}{d+\omega}\left[(r_S - r_{SM})\frac{\partial^2 S}{\partial r^2{}_S} + 2\frac{\partial S}{\partial r_S}\right] + \lambda \frac{\partial^2 \pi}{\partial r^2{}_S} < 0 \tag{48}$$

The financial surplus' (π) change upon the change of loan and deposit interest rates (the first-order derivative of the function π in respect to r_L and r_S):

$$\text{Complete borrower preference } (\gamma = 1);\ (\sigma = 0)\ \frac{\partial \pi}{\partial r_L} > 0;\ \frac{\partial \pi}{\partial r_S} = 0 \tag{49}$$

$$\text{Neutrality } (\gamma = 0.5);\ (\sigma = 0.5)\ \frac{\partial \pi}{\partial r_L} > 0;\ \frac{\partial \pi}{\partial r_S} < 0 \tag{50}$$

Complete saver preference $(\gamma = 0);\ (\sigma = 0)\ \dfrac{\partial \pi}{\partial r_L} = 0;\ \dfrac{\partial \pi}{\partial r_S} < 0$ (51)

Purely commercial approach $(\gamma = 0);\ (\sigma = 0)\ \dfrac{\partial \pi}{\partial r_L} = 0;\ \dfrac{\partial \pi}{\partial r_S} = 0$ (52)

The second-order derivatives of the objective function with respect to r_L and r_S (Equations 47–48) allow for assessing changes in loan and deposit interest rates upon CB's balance-sheet elements and financial surplus (Table 1). The effect of the preference parameters on interest rates (Equations 53–56) is also identified. Estimations reveal that with rising parameter γ (denoting borrower preference), r_L and r_S should fall, whereas with rising parameter σ (saver preference), they should rise.
Response of loan interest rate (r_L) to the borrower-orientation parameter γ (the first-order derivative of the function r_L in respect to the variable γ):

$$\frac{dr_L}{d\gamma} = \frac{\dfrac{1+d}{d+\varphi}\left[(r_{LM} - r_L)\dfrac{\partial L}{\partial r_L} - L\right]\left[\dfrac{\partial \pi}{\partial r_S}\right]^2}{|\Delta|} < 0 \tag{53}$$

Response of deposit interest rate (r_S) to the borrower-orientation parameter γ (the first--order derivative of the function r_S in respect to the variable γ):

$$\frac{dr_S}{D\gamma} = \frac{-\dfrac{1+d}{d+\varphi}\left[(r_{LM} - r_L)\dfrac{\partial L}{\partial r_L} - L\right]\dfrac{\partial \pi}{\partial r_L}\dfrac{\partial \pi}{\partial r_S}}{|\Delta|} < 0 \tag{54}$$

Response of loan interest rate (r_L) to the saver-orientation parameter σ (the first-order derivative of the function r_L in respect to the variable σ):

$$\frac{dr_L}{D\sigma} = \frac{-\dfrac{1+d}{d+\omega}\left[(r_S - r_{SM})\dfrac{\partial S}{\partial r_S} + S\right]\dfrac{\partial \pi}{\partial r_L}\dfrac{\partial \pi}{\partial r_S}}{|\Delta|} > 0 \tag{55}$$

Response of deposit interest rate (r_S) to the saver-orientation parameter σ (the first-order derivative of the function r_S in respect to the variable σ):

$$\frac{dr_S}{D\sigma} = \frac{\dfrac{1+d}{d+\omega}\left[(r_S - r_{SM})\dfrac{\partial S}{\partial r_S} + S\right]\left[\dfrac{\partial \pi}{\partial r_L}\right]^2}{|\Delta|} > 0 \tag{56}$$

Table 1. The response of CB's interest rates to changes in the selected variables – the model

Specification	Orientation of co-operative bank			
	complete borrower preference	the neutrality	complete saver preference	purely commercial orientation
dr_L/dL_0	<0	<0	=0	=0
dr_S/dL_0	=0	>0	>0	=0
dr_L/dr_{L0}	<0	<0	=0	=0
dr_S/dr_{L0}	=0	>0	>0	=0
dr_L/dS_0	>0	>0	=0	=0
dr_S/dS_0	=0	<0	<0	=0
dr_L/dr_{S0}	>0	>0	=0	=0
dr_S/dr_{S0}	=0	<0	<0	=0
dr_L/dP_{Pr}	<0	<0	=0	=0
dr_S/dP_{Pr}	=0	>0	>0	=0
dr_L/dK_{Pr}	>0	>0	=0	=0
dr_S/dK_{Pr}	=0	<0	<0	=0
dr_L/dI_0	<0	<0	=0	=0
dr_S/dI_0	=0	>0	>0	=0
dr_L/dr_{IM0}	<0	<0	=0	=0
dr_S/dr_{IM0}	=0	>0	>0	=0
dr_L/dI	<0	<0	=0	=0
dr_S/dI	=0	>0	>0	=0
dr_L/dr_{IM}	<0	<0	=0	=0
dr_S/dr_{IM}	=0	>0	>0	=0
dr_L/dP_{RK}	<0	<0	=0	=0
dr_S/dP_{RK}	=0	>0	>0	=0
dr_L/dK_{RK-}	>0	>0	=0	=0
dr_S/dK_{RK-}	=0	<0	<0	=0
dr_L/dP_{op}	<0	<0	=0	=0
dr_S/dP_{op}	=0	>0	>0	=0
dr_L/dK_{op}	>0	>0	=0	=0
dr_S/dK_{op}	=0	<0	<0	=0
dr_L/dP_{rez}	<0	<0	=0	=0
dr_S/dP_{rez}	=0	>0	>0	=0
dr_L/dK_{rez}	>0	>0	=0	=0
dr_S/dK_{rez}	=0	<0	<0	=0
dr_L/dK_{Dz}	>0	>0	=0	=0
dr_S/dK_{Dz}	=0	<0	<0	=0
dr_L/dK_A	>0	>0	=0	=0
dr_S/dK_A	=0	<0	<0	=0
dr_L/dZ_{nad}	<0	<0	=0	=0
dr_S/dZ_{nad}	=0	>0	>0	=0
dr_L/dS_{nad}	>0	>0	=0	=0
dr_S/dS_{nad}	=0	<0	<0	=0
dr_L/d_{Kun}	>0	>0	=0	=0
dr_S/d_{Kun}	=0	<0	<0	=0
dr_L/dU_1	>0	>0	=0	=0
dr_S/dU_1	=0	<0	<0	=0
dr_L/dU_0	≤ 0; $\mu \leq 1$	≤ 0; $\mu \leq 1$	=0	=0
dr_S/dU_0	=0	≥ 0; $\mu \leq 1$	≥ 0; $\mu \leq 1$	=0

Source: Own research.

According to obtained results, loan interest rate (r_L) under CB's policy preferring entirely borrowers is lower compared with that under purely commercial orientation, while saving interest rates (r_S) are identical for both orientations. It suggests that when CB is focusing on borrowers its whole financial surplus is used for subsidising (reducing) loan interest rates. If just savers are preferred by CB, estimated optimal interest rates are either equal (r_L) to or higher (r_S) than relevant interest rates under commercial orientation. In that case savers benefit from deposit interest rates subsidised with resources derived from CB's financial surplus. In the neutral CB loan interest rate (r_L) resulted to be higher compared with its level in entirely borrower-oriented bank and lower than that in complete saver-oriented bank. The reverse is found for deposit interest rate (r_S), i.e. under the neutrality its level exceeds that obtained for borrower orientation but is below that under saver orientation.

Referring to Table 1, the general observations on behaviour of interest rates are as follows:

- Loan interest rate (r_L) does not move with an increase in explanatory variables when CB prefers savers or is business-oriented. Respectively, deposit interest rate (r_S) does not change if bank focuses on borrowers or is business-oriented.
- In neutral and borrower dominated bank, r_L declines when the variables from assets side of balance sheet rise. The saver and neutral preferences imply that r_S rises along with increasing asset variables. Growing balance-sheet liabilities result in higher loan price (r_L) in borrower and neutral orientations and lower deposit rate (r_S) in saver and neutral orientations.
- Increasing bank costs lead to higher loan interest rate (r_L) under borrower-oriented and neutral policy as well as to lower deposit interest rate (r_S) under neutral- and saver--oriented policy.
- As bank revenues (regardless of their type) go up, r_L falls in CB focused on borrowers or neutrally oriented, and r_S falls when CB either prefers savers or is neutrally oriented.
- When retained profit (U_1) rises, an adjustment of interest rates (r_L and r_S) in CB is alike that for costs rise. When profit retained from previous period (U_0) increases, a response of interest rates is the same like in the case of rising revenues but under condition that U_0 is partially used to subsidise interest rates (r_L and r_S). When total U_0 goes to build up a CB's capital or else to pay dividends, r_L and r_S will change under all the four approaches.

SUMMARY AND CONCLUSIONS

This study presents a formal theoretic framework seeking to explain a co-operative bank's behaviour of setting loan and deposit interest rates that maximize benefits for bank members-customers. According to the model results, the interest rates which maximize gains for savers and borrowers essentially depend upon bank orientation but are also affected by market interest rates and CB's balance sheet and income statement elements. Loan interest rate will be the lowest if CB is focusing on borrowers, while the highest one when it adopts both commercial and saver orientation. Deposit interest rate is the lowest

under commercial and borrower-oriented policy while the top one – under saver-oriented policy.

In our opinion, the co-operatives, represented in our study by a bank, should treat all member customers equally. Considering dual roles of CB's members as borrowers and lenders, bank neutral policy can help to ease conflict between them. Since CB is democratic organization, in practice, however, the median owner's (member's) preferences are pivotal.

The advantage of the presented model lies in incorporating economic and social aspects of CB's activity. Its construction considers CBs' specific mission of which finally is to support and benefit their members (owners). The model may be useful to bank managers for setting, *ex post* assessing and *ex ante* planning of deposit and loan interest rates. Its limitation arises from the assumption (based on Polish facts) that CB's member and non-member customers have the same terms and conditions of using bank services.

Institutionally forbidden interest rate discrimination by CBs in Poland possibly impedes their existing and potential membership base. The banking law should then allow for privileged treatment of CB's members as regards loan and deposit pricing since it would attract new members and stem exit of current ones. The growth in the membership base would contribute to rise in bank's own capital which essentially determines the scale of banking activities. Additionally, mutual benefits could be derived from the use of more local savings (raised as deposits with CBs) to finance local socio-economic activities and investments.

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USTALANIE OPTYMALNYCH STÓP PROCENTOWYCH OD DEPOZYTÓW I KREDYTÓW W BANKACH SPÓŁDZIELCZYCH

Streszczenie. W artykule podjęto się teoretycznie rozwiązać problem ustalania stóp procentowych od depozytów i kredytów przez bank spółdzielczy w przypadku braku ich różnicowania dla członków (właścicieli) banku oraz pozostałych klientów. W modelu optymalizacyjnym przyjęto trzy warianty preferencji klientów przez bank: orientacja na kredytobiorców, orientacja na depozytariuszy oraz polityka zorientowana neutralne, jak również podejście czysto komercyjne (nastawione na zysk). Według uzyskanych wyników, wysokość optymalnych stóp procentowych od kredytów i depozytów w banku spółdzielczym zależy przede wszystkim od jego preferencji. Znajdują się one również pod wpływem

rynkowych stóp procentowych oraz elementów bilansu oraz rachunku zysków i strat banku. Badanie może przyczynić się do lepszego zrozumienia funkcjonowania banku spółdzielczego, jako podmiotu ekonomii społecznej, oraz uzupełnia dotychczasową literaturę w zakresie modelowania optymalnych stóp procentowych w spółdzielczych instytucjach finansowych.

Słowa kluczowe: bank spółdzielczy, ekonomia społeczna, stopy procentowe, depozyty, kredyty

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