Non-Maturity Deposits with a Fidelity Premium

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We show the existence of an additional term in the valuation formula, the premium complement, allowing the total remuneration rate to be higher than the short-term interest rate and still yield positive net present value. The premium complement depends positively on the base deposit spread during the holding period and negatively on the proportion of stable deposits. Hence, the model explains why a rational bank may offer a fidelity premium higher than the deposit spread.

The 11-year data provided by a European regional bank are used to empirically compare the valuation models. The results show that the proportion of stable deposits plays an important role in the valuation and must be taken into account accurately. The effect of changes in the remuneration policy on the optimal proportion of stable deposits is also analysed.

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Non-Maturity Deposits with a Fidelity Premium

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Abstract

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1. Introduction

The remuneration rate is a major characteristic of non-maturity deposits. Most studies consider this rate as unique, but in some countries, the remuneration depends on how long the money has been invested. This paper focuses on the influence of the remuneration scheme on the valuation of non-maturity deposits. We consider the case where the remuneration of a deposit is split in two parts: a first interest is paid on the current balance and an additional premium rewards the deposits that have remained on the account for a certain period.

Non-maturity deposits represent all bank deposits which have no contractual maturity and for which depositors have the possibility to add and withdraw funds at any time without any restriction. Their rates are usually linked to the market rate.

Deposits are a major source of funding for financial institutions. In Europe, at the end of 2002, total deposits represented on average 42% of the total asset\(^2\). A substantial part of it consists of non-maturity deposits. In Belgium\(^3\) for example, they represent on average 15 to 20% of the bank’s total assets: around 40% of the total liabilities are client deposits of which around 35% are non-maturity deposits.

These deposits are also encouraged by governments as they constitute the ideal tool for individual modest savings. The interests paid on non-maturity deposits often benefit from low tax levels but their rates are highly regulated. Indeed, the remuneration is either fixed by the government (as in France) or capped at a given level (as in Belgium). The reason for this is to avoid financial distress due to too high remuneration rates.

Valuing non-maturity deposits is a difficult task due to the variability of the balance over an indefinite period. It has, however, become necessary in the context of the consolidation trend in the banking industry and the mark-to-market based risk management. As a general principle, the value of a deposit is the difference between its nominal balance and its net present value (NPV). The latter is the cost of replicating the cash flows of the deposit franchise from other funding sources. It does not depend on the

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\(^2\) European Banking Federation (2002).

\(^3\) Commission Bancaire et Financière (2002).
way these funds are allocated within the bank. There is no market reference but the deposit premium\(^4\) may be estimated from banks or branch sale prices.

As non-maturity deposits can be seen as floating rate instruments paying an interest per period less net servicing cost\(^5\), the net remuneration rate has to be compared with the short-term market rate. According to the valuation model described in Jarrow and van Deventer (1998) (called hereafter JvD), the net present value of a deposit is positive if the remuneration rate is mostly lower than the market interest rate, i.e., if the deposit spread is globally positive. The net present value results from the bank’s decision and, subsequently from the clients’ behaviour. Indeed, the financial institution unilaterally sets the level of the deposit rate and the investors act on their deposit balance.

Most empirical studies report positive spread and thus positive net present values [e.g., Berkovec \textit{et al.} (1997) and O’Brien (2000)] although the occurrence of a negative spread in case of low interest rates might be observed [OTS (1994)]. From the bank’s point of view, the level of the deposit rate is set either to achieve a certain margin [Selvaggio (1996)] or to maximise the profit [Hutchison and Pennacchi (1996)]. Moreover, with few exceptions\(^6\) one observes a slow and asymmetric adjustment to interest change tilted toward slow upward adjustment [e.g. O’Brien \textit{et al.} (1994), Rigsbee \textit{et al.} (1996), Janosi \textit{et al.} (1999), Hawkins and Arnold (2002)]. From the client’s point of view, the aggregate balance is well explained by the market interest rates [e.g., van Deventer and Imai (1996)] and the deposit spread [e.g., Hutchison and Pennacchi (1996)] within a local market context described by the level of competition [Berkovec \textit{et al.} (1997)] and the state of the economy [O’Brien (2000)]. More specifically, the deposit balance reacts negatively to both market interest rate and deposit spread. However, this reaction is sluggish: depositors do not immediately withdraw their money when the rates on alternative investments are higher [e.g., Janosi \textit{et al.} (1999), De Jong and Wielhouwer (2001)].

\(^4\) The deposit premium is the net present value given as the percentage of the nominal balance.

\(^5\) Usually, non-interest costs are set as a fixed proportion of the deposit balance. For example, the Office of Thrift Supervision set this proportion at 20bp annual in 2003 [OTS (2003)]. Moreover, O’Brien (2000) shows that the changes in the annual costs per deposit are small and unrelated to the deposit rates. Hence, the two core characteristics of non maturing deposits are the balance and the remuneration rate.

\(^6\) Only a few studies do not report this type of characteristic [Goose \textit{et al.} (1999)].
On the theoretical side, Hutchison and Pennacchi (1996) enlighten the importance of the balance elasticity to interest rate and show that the spread is directly linked to the level of the balance elasticity to interest rates. If the balance is totally elastic, the spread disappears. Hence, there is a trade-off between the benefit of increasing the interest rate spread and the cost of losing deposit market shares. However, O’Brien (2000) stresses that this optimisation leads to symmetric deposit rate adjustment. Jarrow and van Deventer (1998) provide a market segmentation argument. Since only few banks issue deposits, the investors cannot arbitrage away a positive deposit spread. These market imperfections can be due to entry barriers, such as regulatory barriers or fixed costs (e.g., capital requirement and expertise).

The issue of the clients’ slow and incomplete reaction to deposit rate changes has also been addressed by Ausubel (1991), who puts forward the role of the barriers to mobility due to search and switching costs. Jarrow and van Deventer (1998) mention the joint services: clients accept low deposit rates because they receive other advantages and services. Kahn et al. (1999) prove the impact of limited recall\(^7\). Indeed, even a low level of limited recall can produce a significant price clustering and stickiness. Finally, the market concentration may also explain depositors’ rigidity [Hannan and Berger (1991), Berkovec et al. (1997) and Kahn et al. (1999)].

Few papers focus on the deposit valuation model. On the remuneration rate side, Goose et al. (1999) study the effect of legal and commercial constraints. They show that the deposit value exhibits some special features around the constraints and thus must be taken into consideration for interest rate risk management. The asymmetric adjustment of the remuneration rate to interest rate changes typically implies asymmetric deposit durations [e.g., De Jong and Wielhouwer (2001), Hawkins and Arnold (2002)]. On the balance side, Kalkbrener and Willing (2004) show that the introduction of a stochastic factor allows the correlation between the balance and the market rates to be closer to the observed one and offers a better measure for the liquidity risk.

This paper compares different mechanisms of deposit remuneration. The JvD valuation model is extended to the case where a premium is added to the “base interest” for deposits with long-holding periods, as is the case in countries like the Netherlands,

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7 Limited recall is a process by which a depositor truncates components of a deposit rate when storing that rate in memory. The method of truncation can differ across depositors. For example, a deposit rate of 6.32% might be remembered as 6.00%, 6.30% or 6.25%.
Belgium and Luxembourg. We show that this “fidelity premium” might be higher than the basic deposit spread and still yield a positive net present value. Moreover, the proportion of stable deposits plays an important role in the valuation: the lower this proportion, the higher the NPV. Obviously, for high proportions the NPV comes closer to the JvD deposit value where the remuneration rate is the sum of the base rate and the premium rate. Furthermore, the level of the premium is linked to the proportion of stable deposits. Indeed, a high fidelity premium is an incentive to hold the deposit for a longer period. These features explain the attractiveness of a “double” remuneration scheme and its wide use when allowed.

The remainder of this paper is organised as follows: Section 2 reviews the standard valuation model of non-maturity deposits. Section 3 extends this model by introducing a fidelity premium rate. The different models are tested on real data in Section 4 and Section 5 concludes.

2. Jarrow-van Deventer (JvD) valuation model

According to the standard valuation model proposed by Jarrow and van Deventer (1998), we consider a discrete time economy with trading dates \( t \in \{0,1,2,...,T\} \) with two types of agents, banks and individuals trading on two markets, the deposit market and the money market. The latter is open to both agents without restriction but only a limited number of banks can issue deposits.

Several instruments are traded on the money market: all maturity zero-coupon bonds and a money market account. The price at time \( t \) of a zero-coupon bond paying 1 with certainty at time \( \tau \) is \( P(t,\tau) \). The spot rate at time \( t \) is thus defined by:

\[
r_t = \frac{1}{P(t,t+1)} - 1 \tag{1}
\]

The value of a money market account, \( B_t \), is obtained by rolling over the shortest maturity zero-coupon bond:

\[
B_{t+1} = B_t (1 + r_t) \text{ with } B_0 = 1 \tag{2}
\]

---

8 The deposit spread is the difference between the short-term market rate and the base remuneration rate.
Moreover, it is assumed that there exists a unique equivalent probability measure such that the conditional expectation satisfies the following equation:

\[ P(t, \tau) = E_i \left\{ \frac{P(t + 1, \tau)}{1 + r_i} \right\} = E_i \left\{ \frac{1}{B_i} \right\} B_i \text{ for all } 0 \leq t < \tau \quad [3] \]

Hence, the money market is complete and there are no arbitrage opportunities for either banks or individuals\(^9\). Banks issue deposits which can be seen as floating rate instruments paying an interest every period\(^10\). The variables influencing the value of a deposit account are the following:

- \( D_t \geq 0 \) is the volume added to the deposit account at time \( t \).
- \( N_t \geq 0 \) is the nominal balance at time \( t \), which depends on past \( D_t \)'s.
- \( r_t \) is the one-period risk free rate at period \( t \) (Equation [1])
- \( B_t \) is the value of the money market account (Equation [2]). It is used to discount the cash flows in a risk neutral world.
- \( i_t \) is the deposit base rate at time \( t \).
- \( \beta_t = r_t - i_t \) is the deposit spread.

Individuals have a one-period liquidity option. This is introduced in the model as the withdrawal of the deposit at the end of each period and its reinvestment at the beginning of the next one. The remuneration is paid at the end of each period depending on the rate set at the beginning of that period. Table 1 shows the stream of cash flows and the balance evolution of the deposit account.

\[ \square \textbf{Table 1:} \text{Cash flow stream of the deposit account (JvD case)} \]

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>...</th>
<th>( T-1 )</th>
<th>( T )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition</td>
<td>+( D_0 )</td>
<td>+( D_1 )</td>
<td>+( D_2 )</td>
<td>...</td>
<td>+( D_{T-1} )</td>
<td>( D_T )</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>-( D_0 )</td>
<td>-( D_1 )</td>
<td>-( D_2 )</td>
<td>...</td>
<td>-( D_{T-2} )</td>
<td>-( D_{T-1} )</td>
</tr>
<tr>
<td>Interest</td>
<td>-( i_0 D_0 )</td>
<td>-( i_1 D_1 )</td>
<td>-( i_2 D_2 )</td>
<td>...</td>
<td>-( i_{T-2} D_{T-2} )</td>
<td>-( i_{T-1} D_{T-1} )</td>
</tr>
<tr>
<td>Balance</td>
<td>( D_0 )</td>
<td>( D_1 )</td>
<td>( D_2 )</td>
<td>...</td>
<td>( D_{T-1} )</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^9\) Note that if there are restrictions on short selling for individuals, there might remain some arbitrage opportunities for banks.

\(^{10}\) The servicing costs to be deducted from interest payment are ignored for simplicity.
The nominal balance is simply given by the amount deposited on the deposit account: \( N_t = D_t \quad \forall t \in \{0, T - 1\} \) and \( N_T = 0 \). We will see later on that this equality is not verified for other remuneration specifications. The cash flows correspond to the amount put on the deposit account (addition), the amount removed (withdrawal) and the remuneration paid to the deposit holder (interest). Under the assumption that the deposit rate and the volume of the deposit depend only on the information on the money market, a risk neutral valuation procedure is used to compute the net present value of the deposit:

\[
NPV_0 = E_0 \left\{ \sum_{t=0}^{T-1} \frac{D_t(r_t - i_t)}{B_{t+1}} \right\},
\]

\( NPV_0 \) depends on the evolution of the deposit amounts and of the level of the deposit spread. Several deposit rate specifications might be compared:

- \( i_t = r_t \). The net present value is zero.

- \( i_t = r_t - \beta_t \). The net present value is positive if the deposit spread is positive “sufficiently often”.

- \( i_t = r_t - \beta \). When the deposit spread is constant, \( NPV_0 \) can be decomposed into the constant deposit spread and the present value of the future volume:

\[
NPV_0 = \beta E_0 \left\{ \frac{D_t}{B_{t+1}} \right\}.
\]

As the deposit amount is non negative, the sign of the net present value is the sign of the deposit spread i.e., if \( \beta \geq 0 \), then \( NPV_0 \geq 0 \).
3. Extension to a double remuneration scheme

In this section, we extend the JvD valuation model to the case in which deposits have a one-period liquidity option and an additional remuneration is paid if the option is not exercised.

Two new parameters enter the model:

- $\alpha$ ($0 \leq \alpha \leq 1$) is the proportion of the amount put on the account that remains on it for two periods. This proportion is assumed to be constant. Hence, when an amount $D_t$ is put on the account at time $t$, the bank knows that $(1-\alpha)D_t$ will be withdrawn one period later (at time $t+1$) and $\alpha D_t$ will remain until $t+2$. The latter amount is the stable deposits while the former is called the variable deposits.

- $p_t \geq 0$ is the fidelity premium at time $t$, for the balance remaining on the account for two periods. The rate is compounded on a period basis. Thus the two-period interest premium paid is given by: $2p_tD_t$.

3.1. A one-period liquidity option and two-period fidelity premium

Let us assume that individuals have a one-period liquidity option but if they do not exercise it and thus withdraw their deposit at the end of the second period, their remuneration rate is increased. More specifically, the evolution of a deposit $D_t$ added on the bank account at time $t$ is the following:

- At time $t+1$, the bank pays a “base” interest, $i_t D_t$, and the investor withdraws part of the deposit, $(1-\alpha)D_t$. Hence, only $\alpha D_t$ remains on the account.

- At time $t+2$, the bank pays a base interest on the remaining amount, $i_{t+1} \alpha D_t$, and adds a fidelity premium, $2p_{t+1} \alpha D_t$. Then, the investor withdraws the remainder of the deposit.


Table 2: Cash flow stream of the deposit account (fidelity premium case)

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T$</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>...</td>
</tr>
<tr>
<td>Addition</td>
<td>$+D_0$</td>
<td>$+D_1$</td>
<td>$+D_2$</td>
<td>$+D_3$</td>
<td>...</td>
<td>$+D_{T-1}$</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>$-(1-\alpha)D_0$</td>
<td>$-(1-\alpha)D_1$</td>
<td>$-(1-\alpha)D_2$</td>
<td>...</td>
<td>$-(1-\alpha)D_{T-2}$</td>
<td>$-(1-\alpha)D_{T-1}$</td>
</tr>
<tr>
<td>Interest</td>
<td>$-i_0 D_0$</td>
<td>$-i_1 D_1$</td>
<td>$-i_2 D_2$</td>
<td>...</td>
<td>$-i_{T-2} D_{T-2}$</td>
<td>$-i_{T-1} D_{T-1}$</td>
</tr>
<tr>
<td>Premium</td>
<td>$-2p_1 \alpha D_0$</td>
<td>$-2p_2 \alpha D_1$</td>
<td>...</td>
<td>$-2p_{T-2} \alpha D_{T-2}$</td>
<td>$-2p_{T-1} \alpha D_{T-1}$</td>
<td>$-2p_T \alpha D_T$</td>
</tr>
<tr>
<td>Balance</td>
<td>$D_0$</td>
<td>$D_1+\alpha D_0$</td>
<td>$D_2+\alpha D_1$</td>
<td>...</td>
<td>$D_{T-1}+\alpha D_{T-2}$</td>
<td>$D_T+\alpha D_{T-1}$</td>
</tr>
</tbody>
</table>

The nominal balance (see Table 2) is now given by the sum of the amount deposited at that period and the stable deposit of the previous period: $N_t = D_t + \alpha D_{t-1}$, $t = 1..T-1$ with $N_0 = D_0$ and $N_T = 0$. The cash flows at time $t$ derive from the deposit introduction and withdrawal (of variable short-term deposit and stable long term deposit) and from interest payment (at base rate for the total previous nominal volume and at fidelity premium rate for the stable deposit amount). Discounting these cash flows yields:

$$NPV_0 = E_0 \left( \sum_{t=0}^{T-2} \frac{D_t \left( (1+r_{t+1}) \left( r_i - i_t \right) + \alpha (r_{t+1} - i_{t+1} - 2p_t) \right)}{B_{t+2}} \right) + \frac{D_{T-1} (r_{T-1} - i_{T-1})}{B_T} \right)$$  \[6\]

$NPV_0$ depends on the evolution of the deposit amounts and the remuneration rates (base and fidelity premium). Note that if $\alpha$ is set a zero, Equation 6 simplifies to Equation 4.

In the previous case (JvD), the discussion on the sign of the $NPV_0$ focused on the comparison between the deposit rate and the market rate. However, in the current case, one cannot simply add the fidelity premium rate to the base rate and compare this sum to the market rate. Actually, the condition put on the fidelity premium payment allows the premium rate to be higher than the base spread and still yield a positive net present value.

Without loss of generality, the final term will not be taken into account in the discussion. Indeed, this term is due to the time limit of the model. In the case of on-going activities, the limit is set at infinity and the final term should thus be negligible.

$^{11}$ See Appendix 2 for details.
Several deposit base rate specifications are analysed:

- $i_t = r_t$. The net present value directly depends on the premium. As this premium is non negative, the net premium value cannot be positive and is equal to zero only if the premium is zero:

$$NPV_0 = E_0 \left\{ - \sum_{t=0}^{T-2} \frac{\alpha 2 p_t D_t}{B_{t+2}} \right\}$$  \[7\]

- $i_t = r_t - \beta$. $NPV_0$ depends on the evolution of the deposit amount, the deposit spread, the future interest rate, the proportion of stable deposits and the fidelity premium:

$$NPV_0 = E_0 \sum_{t=0}^{T-2} \frac{(1+r_{t+1})\beta + \alpha (\beta - 2 p_t) D_t}{B_{t+2}}$$  \[8\]

The fidelity premium can be higher than the deposit spread, i.e., $i_t + p_t \geq r_t$, and still yield a positive net present value. Indeed, the $NPV_0$ is non negative if the following condition is verified:

$$(1+r_{t+1})\beta + \alpha (\beta - 2 p_t) \geq 0$$  \[9\]

which can be rewritten as:

$$p_t \leq \beta + \frac{\beta - 1}{2 \alpha \text{ premium complement}} \alpha + r_{t+1}$$  \[10\]

The second term of the right hand side of \[10\] is the premium complement. If the deposit base rate spread is positive, this additional term is always positive\(^\text{12}\). It represents the maximum spread between $p_t$ and $\beta$ under which the $NPV_0$ remains positive.

If $\alpha$ is zero, the addition term is infinite indicating that there is no limit on the premium rate. Indeed, as all the deposit is variable, the fidelity premium will never be paid and the premium rate is thus not important. On the contrary, if $\alpha$ is 100%, the premium complement is minimum. As all the deposits are stable, the total remuneration is the sum of the base rate and the fidelity premium. The delay

\(^{12}\) The premium complement is positive because $r_{t+1} \geq 0$, $(1-\alpha) \geq 0$ and $\alpha \geq 0$.  

10
in the payment of the fidelity premium induces a little difference with the JVD model: the premium rate might be slightly higher than the base spread and still yield a positive NPV.

The existence of the premium complement explains why a rational financial institution may offer a combination of base rate and interest premium which is higher than the one-period market rate\(^\text{13}\).

The premium complement depends positively on the deposit spread and on the market rate and negatively on the proportion of stable deposits. Indeed, this term stems from the “profit” that the bank has already made by paying a low base rate on the variable deposit. Hence, if the proportion of stable deposits is low, the “profit” made on the first period is high and the premium complement is high.

Table 3 gives the limit of the fidelity premium corresponding to different deposit base spreads (\(\beta\)) and proportions of stable deposits (\(\alpha\)) for a given market interest rate of 4%. For example, if the proportion of stable deposits is 40% and the deposit base spread is 1.5% (implying that the deposit base rate is 2.5%), then any fidelity premium lower than 2.7% yields a positive net present value. We note that, even with 100% of stable deposits, the premium complement is not zero. This is due to the capitalization of the past base spread.

\[\text{Table 3: Limit of the fidelity premium rate for different proportions of stable deposits and different base spread (market rate of 4%)}\]

\[
\begin{array}{cccccc}
\hline
\alpha & 0.5% & 1.0% & 1.5% & 2.0% & 2.5% \\
\hline
0% & --- & --- & --- & --- & --- \\
10% & 2.85% & 5.70% & 8.55% & 11.40% & 14.25% \\
20% & 1.55% & 3.10% & 4.65% & 6.20% & 7.75% \\
30% & 1.12% & 2.23% & 3.35% & 4.47% & 5.85% \\
40% & 0.90% & 1.80% & 2.70% & 3.60% & 4.50% \\
50% & 0.77% & 1.54% & 2.31% & 3.08% & 3.85% \\
60% & 0.68% & 1.37% & 2.05% & 2.73% & 3.42% \\
70% & 0.62% & 1.24% & 1.86% & 2.49% & 3.11% \\
80% & 0.58% & 1.15% & 1.73% & 2.30% & 2.88% \\
90% & 0.54% & 1.08% & 1.62% & 2.16% & 2.69% \\
100% & 0.51% & 1.02% & 1.53% & 2.04% & 2.55% \\
\hline
\end{array}
\]

\[r_i > \beta \iff i_i + p_i > r_i\]

\(^{13}\)
• $i_t = r_t - \beta_t$. When the deposit base spread is not constant, the net present value can be rewritten as:

\[
NPV_0 = E_0 \left\{ \sum_{t=0}^{T-2} \frac{\left( (1 + r_{t+1})\beta_t + \alpha(\beta_{t+1} - 2p_t) \right)D_t}{B_{t+2}} \right\}
\]

[11]

The inequality ensuring that the $NPV_0$ is non negative (Equation [10]) becomes:

\[
p_t \leq \frac{\beta_t + \beta_{t+1}}{2} + \beta_t \frac{1 - \alpha + r_{t+1}}{2\alpha}
\]

[12]

This expression enlightens the difficulty for a bank at time $t$ to set the fidelity premium rate such that inequality [12] is satisfied. Indeed, the maximal premium depends not only on the current short-term rate and current deposit spread, but also on their future values. Thus, the financial institution must forecast them. While the bank has a direct influence on the deposit spread, the short-term interest rates are random. Hence, there is some additional interest rate risk associated to the fidelity premium remuneration. We will see in the next section that this risk can be reduced by relaxing the assumption of a fixed fidelity premium rate.

### 3.2. Discussion of the assumptions

The valuation model of a deposit with double remuneration scheme rests on the assumptions that the fidelity premium is fixed and that the proportion of stable deposits is constant.

The first hypothesis is not realistic but the model can be easily adapted to the observed practices. Indeed, in the real world, financial institutions adjust the premium rate during the holding period so that the actual premium paid on the stable deposit is a time average of the variable premium rates\(^{14}\). The fidelity premium rate is thus not fixed but the net present value is then given by:

\[
NPV_0 = E_0 \left\{ \sum_{t=0}^{T-2} \frac{\left( (1 + r_{t+1})\beta_t + \alpha(\beta_{t+1} - (p_t + p_{t+1})) \right)D_t}{B_{t+2}} \right\}
\]

[13]

\(^{14}\) More specifically, the bank has the opportunity to set a new fidelity premium rate at any time. The calculation of the total premium consists in averaging the different rates prorata temporis.
The condition on the premium rate can be rewritten as:
\[
\frac{p_t + p_{t+1}}{2} \leq \beta_t + \frac{\beta_{t+1}}{2} + \frac{1 - \alpha + r_{t+1}}{2\alpha} \quad [14]
\]

This model specification does not affect the general conclusion on the premium complement term. Actually, it merely induces that the bank takes less risk than when the premium rate is fixed.

Our model also relies on the assumption of a constant proportion of stable deposits. In fact, it results from the investors' decision to exercise or not the one-period option. This decision depends on the individuals' needs and on the fidelity premium rate. Indeed an attractive premium rate encourages short-term investors to postpone their withdrawal and discourages long term investors to turn to the money market. This implies a high proportion of stable deposits. Moreover, this proportion is smaller than 100% because individuals' might have unpredicted future cash needs and because the access to the money market is not totally free to individual investors\(^{15}\).

If individuals' needs are assumed to be stable over time, we can say that the proportion of stable deposits is mainly a result of the bank's remuneration policy. This is part of the bank reputation\(^ {16}\) and thus should not vary widely over time. We can therefore expect the proportion of stable deposits to be relatively constant for a given financial institution. Indeed, this is what we observe in the empirical example presented in Section 4.

\(^ {15}\) If short selling is restricted, even the predicted cash needs cannot be satisfied by the money market.

\(^ {16}\) Some banks are reputed to offer high/low remuneration rates whatever the market interest rate.
3.3. Generalisation to an annual setting

Traditionally, monthly data are used to compute the NPV of deposit accounts and the minimum holding period required to receive a fidelity premium is one year. Therefore, in order to compare the \( NPV_0 \) models on a real example, we generalise the valuation model of Section 3.1. to the case of a one-month liquidity option and a twelve-month fidelity premium.

The net present value becomes\(^{17}\):

\[
NPV_0 = E_0 \left\{ \sum_{t=0}^{T-12} D_t \left[ (r_i - i_0) \prod_{j=1}^{11} (1 + r_{t+j}) + \alpha \sum_{i=1}^{10} (r_{t+i} - i_{t+i}) \prod_{j=i+1}^{11} (1 + r_{t+j}) + \alpha (r_{t+11} - i_{t+11} - 12 p_t) \right] \right\} B_{T-12}
+ \sum_{t=3}^{T-1} \left[ D_{T-t-1} \left( r_{T-t-1} - i_{T-t-1} \right) \prod_{k=1}^{t-2} (1 + r_{T-t-k}) + \alpha \sum_{m=2}^{t-1} (r_{T-m} - i_{T-m}) \prod_{k=1}^{m-1} (1 + r_{T-k}) + \alpha (r_{T-1} - i_{T-1}) \right] B_T
+ \frac{D_{T-2}(r_{T-2} - i_{T-2})(1 + r_{T-1}) + \alpha(r_{T-1} - i_{T-1})}{B_T} \right\}
\]

[1]

The nominal volume at time \( t \) is the sum of the amount put on the account at \( t \) and of the past stable deposits. It can be written as:

\[
N_t = D_t + \alpha \sum_{j=1}^{\min(t,11)} D_{T-j}, \ t = 1..T-1 \text{ and } N_T = 0
\]

[2]

In this case, condition [10] becomes:

\[
p_t \leq \beta + \beta \frac{\prod_{j=1}^{11} (1 + r_{t+j}) + \alpha \left( \sum_{i=1}^{10} \prod_{j=i+1}^{11} (1 + r_{t+j}) - 11 \right)}{12 \alpha}
\]

[3]

We show in Appendix 4 that the premium complement is always positive. The link with Equation [10] can be realised by considering the capitalisation of the base spread over 12 periods instead of 2.

\(^{17}\) See Appendix 3 for details.
4. An empirical approach

We apply the previous models to real data from a European regional financial institution which offers a double remuneration scheme. This allows us to determine the difference between our model and a simple adaptation of the JvD model.

4.1. Data description

The database consists of 130 monthly observations of the one-month market interest rate, the nominal deposit account volume, the deposit base rate and the fidelity premium rate over an 11-year period (from April 1993 to February 2004). These data are provided by a European regional bank, which is relatively small compared to the national and international players who are active on that market. This explains why the remuneration rate for both base and fidelity premium rate is relatively high.

The evolution of the one-month risk free rate is depicted in Figure 1. During the last 10 years, the short-term rate has been relatively low. It was mainly decreasing except during the 2000-2001 period. Hence, following the literature, we should observe an increase in the nominal volume when market rates are decreasing (and vice-versa), because then there is less advantage to turn to the money market [e.g., van Deventer and Imai (1996)]. Moreover, the remuneration rate should present a positive spread [Hutchison and Pennacchi (1996)] with an asymmetric adjustment to market rate [e.g., Janosi et al. (1999)].

- Figure 1: The one-month risk free market rate ($r_t$)

---

18 The base rate is offered on all deposits *prorata temporis* and the fidelity premium remunerates the deposits that were held for at least 12 months.
Figures 1 and 2 show that the nominal balance is indeed negatively related to the short-term market rate.

- **Figure 2:** Nominal volume (in $10^9€$)

![Graph showing nominal volume](image)

However, in Figure 3, the predicted relation between the remuneration rate and the market interest rate is less clear. Since the deposit rate is legally capped\(^{19}\) in the bank’s country, the remuneration rate is low compared to the market rate at the beginning of the studied period. The observed total remuneration rate (defined as the sum of the base rate and the fidelity premium rate) is often higher than the short-term market rate. On average over the period, it is 0.2% higher than the market rate. Even the base rate sometimes lies above the market rate but this situation is temporary, a phenomenon that could be attributed to the high competition faced by the bank from which the data come. However, high remuneration rates do not necessarily imply negative NPV over the whole period.

---

\(^{19}\) Basically, the country legislation imposes a maximum base rate of 4% and a maximum fidelity premium of 50% of the base rate.
4.2. Comparison of NPV models

The net present value of the deposits during the 11-year period is computed using different NPV specifications. This allows to enlighten the differences of various treatments of a deposit remuneration composed of a base interest rate, $i$, and a fidelity premium, $p$. Four ways of taking the premium into account are compared. They range from basic JvD model to our extension with variable premium:

- **JvD**: refers to the basic Jarrow-van Deventer (1998) valuation model. In Equation [4], the total remuneration rate is calculated as $i + p$.  

- **Naïve**: adapts the JvD model in a simple way in order to take into account the fact that the fidelity premium is paid only to the stable deposits. In Equation [4], the total remuneration rate is calculated as $i + \alpha p$, where $\alpha$ is the proportion of stable deposits.

- **Fixed Premium**: is our extension of the JvD model. The NPV is calculated though Equation [15]. The fidelity premium is fixed at the beginning of the holding period.

- **Variable Premium**: modifies the previous setting by taking into consideration the fact that the fidelity premium is variable (i.e., the fidelity premium paid on the stable deposits is the average of the variable premium rate over the holding period). In Equation [15], $12p$ is replaced by $p + p_{r1} + ... + p_{r11}$.
For all four specifications, we compute the deposit premium, which is defined as:

\[ DP_0 = \frac{NPV_0}{N_0} \]  

where \( N_0 \) is the initial balance.

Figure 4 shows the deposit premium in April 1993 for different proportions of stable deposits. The table with the numeric results can be found in Appendix 5.

- **Figure 4**: Deposit premium in April 1993 for the 04/93-02/04 period with respect to the proportion of stable deposits

The four valuation models produce deposit premiums, whose reactions to the proportion of stable deposits are quite different. Compared to Variable Premium, the JvD model underestimates the net present value whatever the proportion of stable deposits. On the opposite, the Naïve model mainly overestimates the NPV. This is due to the fact that in the naïve setting the proportion of stable deposits has a linear effect on the NPV while it influences the NPV in the Fixed Premium and Variable Premium models through the \((1-\alpha)/\alpha\) ratio. Finally, the difference between the Fixed Premium and Variable Premium NPV shows that the opportunity to adjust the fidelity premium in a downward interest market is valuable. Indeed, it allows to follow more closely the market movement and thus to avoid too high remuneration rates.

To determine the deposit premium accurately, one needs to know the proportion of stable deposits. The total interest effectively paid on the deposit account during the
The 01/95-01/03 period shows that around 85 to 90% of the maximum fidelity premium\textsuperscript{20} was really paid\textsuperscript{21}. Moreover, the annual percentage is quite stable over time (especially since 1999). This tends to validate the assumption of a constant proportion of stable deposits. Additionally, as the studied financial institution is known to offer high remuneration rates, this high percentage of stable deposits also tends to support the relation between a bank remuneration policy and the proportion of stable deposits.

With a proportion of stable deposits between 85 and 90%, the NPV of the studied deposits is negative whatever the valuation model used. Indeed, the deposit premium lies between -39.5 and -34.5% for the Fixed Premium and Variable Premium model, respectively. This indicates that the high remuneration offered has encouraged individuals not to exercise their one-month option. Actually, with the same remuneration policy, the NPV would have been positive only if the proportion of stable deposits had been less than 20%.

A bank presenting a negative deposit premium should wonder how a change in its remuneration policy would transform the results. In Figure 5, we draw the null NPV line for different remuneration levels in the case of the analysed bank. This line gives the maximum proportion of stable deposits that yields non-negative NPV for all remuneration levels as measured by the Variable Premium model. We modify the observed remuneration policy in three ways:

- **Base**: the premium rate remains unchanged and the base rate is multiplied by a fraction \( m \). The total remuneration rate is: \( m \times i + p \).

- **Premium**: the base rate remains unchanged and the premium rate is multiplied by a fraction \( m \). The total remuneration rate is: \( i + m \times p \).

- **Base and Premium**: Both base rate and premium rate are multiplied by a fraction \( m \). The total remuneration rate is: \( m \times (i + p) \).

\textsuperscript{20} i.e. if the proportion of stable deposits were 100%.

\textsuperscript{21} See Appendix 6.
Figure 5: Null NPV line for different modifications of the remuneration policy

Figure 5 shows that a slight reduction of the base rate increases rapidly the maximum proportion of stable deposits that yields non negative NPV. This maximum proportion is less sensitive to a reduction of the premium. Hence, for the studied financial institution, the value driver of the deposits has been its base rate. Moreover, if the bank had wanted a maximum proportion of stable deposits of 100% and thus be immune with respect to the reaction of the clients, it should have either multiplied the base rate by 0.89 or the premium rate by 0.57.

The conclusion must be drawn with care. Indeed, Figure 5 presents the result in a given environment (decreasing and low interest rates) and for a more general remuneration policy (relatively stable base rate and variable premium rate). Moreover, the computations rest on the assumptions that the investors’ behaviour is independent of the remuneration policy. Anyway, from the bank’s point of view, the large differences between the null NPV curves indicate that the policy redefinition should focus on the base rate.
5. Conclusion

Non-maturity deposits represent a large portion of banks’ balance sheet. Due to their characteristics, the valuation of these liabilities is complex. However, it is fundamental to value the financial activities and to adequately manage interest rate risk.

The usual deposit valuation model as presented by Jarrow and van Deventer (1998) (JvD), assumes the existence of a short-term liquidity options and a single remuneration rates. The net present value of a deposit then stems from the difference between the short-term market rate and the remuneration rate. It is thus positive if the deposit spread is positive “sufficiently often”. However, in the real world, the remuneration rate might be variable and depend on the holding time: the longer the deposit remains in the account, the higher its remuneration.

We extend the valuation model to the case where the deposits present a one-month liquidity option and generate an additional premium for a 12-month holding. The model explains why a rational bank may offer a fidelity premium higher than the deposit spread. Indeed, we enlighten an additional term in the valuation formula, the premium complement, allowing the maximal total remuneration rate\(^{22}\) to be higher than the short-term interest rate and still yield a positive net present value. Broadly, the premium complement depends positively on the base deposit spread during the holding period and negatively on the proportion of stable deposits.

Data from a European regional bank are used to empirically compare the valuation models. The results reveal that, compared to the results of our extended model, simply adding the base rate and the fidelity premium in the JvD model leads to a large underestimation of the deposit NPV. In fact, the proportion of stable deposits plays an important role in the valuation. We also show that taking this proportion into account in a naïve way, i.e., by defining the remuneration as the base rate and a proportion of the premium, also leads to substantial valuation difference.

---

\(^{22}\) The maximal total remuneration rate is the sum of the base rate and the premium rate.
Finally, the maximal proportion of stable deposits is computed under three remuneration policy modifications. This analysis gives insights into the key value drivers and on the main factor to be considered when setting remuneration rates.

The study of more sophisticated remuneration policies in conjunction with a deposit demand analysis should make it possible to determine the optimal remuneration policy of a financial institution in terms of net present value. Note that this optimisation could also be realised to control the sensitivity of the deposit value to interest rates.

6. Bibliography


7. Appendices

7.1. Appendix 1: NPV of a deposit with one-period liquidity option (JvD model)

\[
NPV_0 = E_0 \left\{ D_0 + \sum_{t=1}^{T-1} \frac{D_t - (1 - i_{t-1})D_{t-1} - (1 - i_{T-1})D_{T-1}}{B_t} \right\} \\
= E_0 \left\{ \sum_{t=0}^{T-1} \frac{D_t(1 + r_t)}{B_{t+1}} - \sum_{t=0}^{T-1} \frac{D_t(1 + i_t)}{B_{t+1}} \right\} \\
= E_0 \left\{ \sum_{t=0}^{T-1} \frac{D_t(r_t - i_t)}{B_{t+1}} \right\} \blacksquare
\]

7.2. Appendix 2: NPV of a deposit with one-period liquidity option and two-period fidelity premium

\[
NPV_0 = E_0 \left\{ D_0 + \frac{D_1 - (1 - \alpha)D_0 - i_0D_0}{B_1} + \sum_{t=2}^{T-1} \frac{D_t - (1 - \alpha)D_{t-1} - \alpha D_{t-2} - i_{t-1}[D_{t-1} + \alpha D_{t-2}]}{B_t} - \sum_{t=2}^{T-1} \frac{2p_{t-2} \alpha D_{t-2}}{B_t} - \frac{D_{T-1} + \alpha D_{T-2} + i_{T-1}[D_{T-1} + \alpha D_{T-2}] + 2p_{T-2} \alpha D_{T-2}}{B_T} \right\} \\
= E_0 \left\{ \sum_{t=0}^{T-2} \frac{D_t(1 + r_t)(1 + r_{t+1})}{B_{t+2}} + \frac{D_{T-1}(1 + r_{T-1})}{B_T} - (1 - \alpha) \sum_{t=0}^{T-2} \frac{D_t(1 + r_{t+1})}{B_{t+2}} - (1 - \alpha) \frac{D_{T-1}}{B_T} - \alpha \sum_{t=0}^{T-2} \frac{2p_{t-1} \alpha D_{t-1}}{B_{t+2}} - \alpha \sum_{t=0}^{T-2} \frac{i_{t+1}D_{t+1}(1 + r_{t+1})}{B_{t+2}} - \frac{i_{T-1}D_{T-1}}{B_T} - \alpha \sum_{t=0}^{T-2} \frac{(i_{t+1} + 2p_t)D_t}{B_{t+2}} \right\} \\
= E_0 \left\{ \sum_{t=0}^{T-2} \frac{D_t[(1 + r_t)(1 + r_{t+1}) - (1 - \alpha)(1 + r_{t+1}) - \alpha - i_t(1 + r_{t+1}) - \alpha(i_{t+1} + 2p_t)]}{B_{t+2}} + \frac{D_{T-1}[(1 + r_{T-1}) - (1 - \alpha) - \alpha - i_{T-1}]}{B_{t+2}} \right\} \\
= E_0 \left\{ \sum_{t=0}^{T-2} \frac{D_t[(1 + r_{t+1})(r_t - i_t) + \alpha(r_{t+1} - i_{t+1}) + 2p_t]}{B_{t+2}} + \frac{D_{T-1}(r_{T-1} - i_{T-1})}{B_T} \right\} \blacksquare
\]
7.3. Appendix 3: NPV of a deposit with one-period liquidity option and twelve-period fidelity premium

<table>
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<tr>
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<th>0</th>
<th>1</th>
<th>2</th>
<th>...</th>
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<th>...</th>
<th>$T$</th>
</tr>
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<tr>
<td><strong>Addition</strong></td>
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<td>$+D_1$</td>
<td>$+D_2$</td>
<td>...</td>
<td>$+D_{12}$</td>
<td>...</td>
<td>$+$</td>
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<td>$-(1-\alpha)D_{11}$</td>
<td>...</td>
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<td>...</td>
<td>$-i_{11} D_{11}$</td>
<td>...</td>
<td>$-i_{T-1} D_{T-1}$</td>
<td>$-i_1 \alpha D_{10}$</td>
</tr>
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<td><strong>Premium</strong></td>
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<td>$-p_1 \alpha D_1$</td>
<td>...</td>
<td>$-p_{T-11} \alpha D_{T-11}$</td>
<td>...</td>
<td>$-p_{T-12} \alpha D_{T-12}$</td>
<td>$-p_1 \alpha D_{10}$</td>
</tr>
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<td><strong>Balance</strong></td>
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<td>$D_1 + a D_0$</td>
<td>$D_2 + a D_1 + a D_0$</td>
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<td>$D_{12} + a D_{11} + \ldots + a D_{1}$</td>
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</table>

$$NPV_0 = E_0 \left\{ D_0 + \sum_{i=1}^{11} \frac{D_i}{B_i} - (1 - \alpha) \sum_{i=1}^{11} \frac{D_{i+1}}{B_i} + \sum_{t=1}^{T-1} \frac{D_t - (1 - \alpha)D_{t+1} - \alpha D_{t+12}}{B_t} \right\}$$

$$= E_0 \left\{ \sum_{i=0}^{T-12} \frac{D_i \prod_{j=0}^{11} (1 + r_{t+j})}{B_{t+12}} - (1 - \alpha) \sum_{i=0}^{T-12} \frac{D_{i+1} \prod_{j=0}^{11} (1 + r_{t+j})}{B_{t+12}} - \alpha \sum_{i=0}^{T-12} \frac{D_{i+1}}{B_{t+12}} \right\}$$

$$+ \sum_{i=0}^{11} \frac{D_{T-i-1} \prod_{k=0}^{11} (1 + r_{T-k})}{B_T} - (1 - \alpha) \sum_{i=0}^{11} \frac{D_{T-i} \prod_{k=0}^{11} (1 + r_{T-k})}{B_T} - \alpha \sum_{i=0}^{11} \frac{D_{T-i}}{B_T}$$

$$- \sum_{t=0}^{T-12} \frac{i_t D_t \prod_{j=0}^{11} (1 + r_{t+j})}{B_{t+12}} - \alpha \sum_{t=0}^{T-12} \frac{i_t D_{t+1} \prod_{j=0}^{11} (1 + r_{t+j})}{B_{t+12}} - \alpha \sum_{t=0}^{T-12} \frac{i_{t+1} D_t}{B_{t+12}}$$

$$- \alpha \sum_{t=0}^{T-12} \frac{12 \rho_t D_t}{B_{t+12}} - \frac{\sum_{i=2}^{11} D_{T-i-1} \prod_{k=0}^{11} (1 + r_{T-k})}{B_T} - \frac{D_{T-i-1}}{B_T}$$

$$- \alpha \sum_{i=0}^{11} \frac{D_{T-i} \prod_{k=0}^{11} (1 + r_{T-k})}{B_T} - \alpha \sum_{i=0}^{11} \frac{i_{T-i} D_{T-i}}{B_T} \right\}$$
7.4. Appendix 4: Sign of the premium complement in the generalized case with fidelity premium

\[ p_t \leq \beta + \beta + \frac{\prod_{j=1}^{11} (1 + r_{r+j}) + \alpha \sum_{l=1}^{10} \prod_{j=l+1}^{11} (1 + r_{r+j}) - 11\alpha}{12\alpha} \]

The premium complement is positive if:

\[ \prod_{j=1}^{11} (1 + r_{r+j}) + \alpha \sum_{l=1}^{10} \prod_{j=l+1}^{11} (1 + r_{r+j}) \geq 11\alpha \]

This is always true because

\[
\begin{align*}
(1 - \alpha) \prod_{j=1}^{11} (1 + r_{r+j}) + \alpha \prod_{j=1}^{11} (1 + r_{r+j}) + \alpha \sum_{l=1}^{10} \prod_{j=l+1}^{11} (1 + r_{r+j}) & \\
\geq 0 & \\
\geq \alpha & \\
\geq 10\alpha & 
\end{align*}
\]
7.5. Appendix 5: Empirical results of the computation of the deposit premium in April 1993 for the 04/93-02/04 period

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<td>48.34%</td>
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7.6. Appendix 6: Empirical results of the computation of the deposit premium in April 1993 for the 04/93-02/04 period

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<th>Proportion (1)/(2)</th>
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<td>2003</td>
<td>5.564</td>
<td>6.251</td>
<td>89%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>2.855</strong></td>
<td><strong>3.179</strong></td>
<td><strong>83%</strong></td>
</tr>
</tbody>
</table>

The maximum fidelity premium is the amount that would have been paid if all the deposits had remained on the account.