Conceptual Paper

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Passing on negative interest rates

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Abstract: Since the ECB has lowered the interest rate on deposits into negative territory, more and more commercial banks are also passing on this negative interest rate to their customers. The main aim of this paper is to answer the question under which conditions the commercial banking sector will be more or less reluctant to pass the negative deposit rate on to its private customers. We first clarify the circumstances under which demand deposits and excess liquidity arise, and what role quantitative easing plays in this context. Within a game-theoretical framework, it is derived that the pressure to pass on the negative interest rate is particularly high if there are no switching costs, and the banking market follows a Bertrand competition.

Keywords: excess liquidity, penalty interest, game theory, investor behavior
JEL Classification: G21, E43, E52

1 Introduction

> "More and more banks and savings banks are also demanding negative interest rates from private customers. At most institutions there are allowances, at others, you pay from the first euro on top." [Bakir, 2019]

In June 2014, the European Central Bank (ECB) lowered the deposit rate into negative territory for the first time. The deposit rate is the interest rate that commercial banks normally receive when they invest overnight – in the so-called deposit facility – liquidity with the central bank. The last time the deposit rate was cut was in September 2019 from – 0.4% to–0.5% [Deutsche Bundesbank, 2019a]. This interest rate also applies to balances held by commercial banks on the central bank's current accounts, i.e. the so-called *"excess liquidity."*. Excess liquidity is the liquidity that commercial banks hold on accounts with the central bank above the minimum reserve requirement [ECB, 2017].

Before the outbreak of the financial market crisis, excess liquidity in the euro area played hardly any role. Only as the crisis unfolded, excess liquidity in the banking sector increased significantly, reaching around 1,800 billion Euro in the euro area in November 2019 [Deutsche Bundesbank, 2019b]. The following countries have mainly built up excess liquidity: Germany, France, the Netherlands, Finland, and Luxembourg [Baldo et al., 2017].

German banks in particular have a structural liquidity surplus of more than 600 billion Euro [Deutsche Bundesbank, 2020a]. Since commercial banks have to pay negative interest rates on surplus liquidity, this also affects their profitability.

The zero lower bound of the interest rate has received already much attention in the macroeconomic literature. For the euro area the term "zero lower bound" refers to the interest of the main refinancing operations. As already mentioned, the interest rate for the deposit is negative already for a longer period. Not too much literature focuses on the link between the negative rate on the deposit facility, the commercial

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banking sector, and its operations with the private sector. Especially, theoretical approaches are rare. We fill this gap in the literature by applying a game-theoretic framework to answer the question under which conditions the commercial banking sector will be more or less reluctant to pass the negative deposit rate on its private customers.

2 Creation of excess liquidity and demand deposits

First, however, it should be clarified which transactions give rise to demand deposits by private customers in the commercial banking sector, and which give rise to excess liquidity of commercial banks at the central bank. This analysis also highlights the link between excess liquidity (EL) and sight deposits.

First of all, the lending of 1,000 € by a commercial bank A to household 1 should be considered. In the amount of this sum, demand deposits (DD) of household 1 with Bank A are created. Furthermore, a cash ratio of 10% and a minimum reserve rate of 1% are assumed. Bank A must then pay out cash in the amount of 100 €. On the remaining 900 € demand deposits, a minimum reserve requirement of 9 € arises. Furthermore, it is assumed that Bank A does not have an EL in the initial situation. The commercial bank has a refinancing requirement, that is, revolving credit facility (RCF) of 109 € with the central bank. The effects of these transactions on Bank A's balance sheet are shown in Account 1. It is clear from the balance sheet that this transaction does not generate excess liquidity.

Account 1: Balance sheet Bank A: Lending (figures in €)

Assets	Liabilities
Credit (Household 1) 1,000	Demand Deposit (Household 1) 900
Minimum reserves 9	RCK 109

In the second example, the effects of the Quantitative Easing (QE) program is discussed[1]. Household 2 sells a security in the amount of 1,000 € to the central bank (see Moritz and Berthold, 2019). However, the ECB does not buy the paper directly from the private household and does not provide it with cash. Instead, the transaction is settled via commercial Bank B. This has the following implications: The sale of the security of 1,000 € results in sight deposits of 1,000 € the resale of the security from Bank B to the central bank gives rise to a credit balance of Bank B with the central bank of 1,000 €. Thus, excess liquidity in the amount of 1,000 € initially arises.

Due to the cash withdrawal of household 2 and the minimum reserve requirement, Bank B has a liquidity requirement of 109 €, which it can cover by redeeming EL. EL remains in the amount of 891 €. The impact of these transactions on Bank B's balance sheet is shown in Account 2:

Account 2: Balance sheet Bank B: Sale of securities (figures in €)

Assets	Liabilities
Credit (Household 2) 1,000	Demand Deposit (Household 2) 900
Minimum Reserves 9	RCK 109

These considerations lead to the following conclusions:

- In the first example, lending by commercial Bank A to household 1 gives rise to demand deposits, but not excess liquidity. Thus the negative penalty interest rate has practically no impact on the commercial bank.

1 At the beginning of 2015 the ECB adopted the so-called "quantitative easing programme" [ECB, 2018]. The aim of the QE is to create monetary impulses for the economy through the purchase of securities and ultimately to defend deflation in the euro area [Deutsche Bundesbank, 2020b].

- In the second example, the sale of securities by households to the central bank via commercial banks generates both excess liquidity and demand deposits. Demand deposits, however, increase more strongly than excess liquidity due to the minimum reserve.

How can commercial banks even react to negative interest rates from the central bank to avoid penalties?

- They could convert their excess liquidity into cash. However, this would entail considerable storage costs (storage in safes and insurance).
- You could make more loans. However, this requires a corresponding demand for credit, and the borrowers must be creditworthy. However, a minimum reserve ratio of 1% and a cash ratio of 10% results in a credit creation multiplier of 9.17. With excess liquidity of 1,800 billion €, the credit volume in the euro area would have to increase by about 16,500 billion € to reduce excess liquidity in the euro area through lending. Accordingly, additional lending by banks will not reduce the current excess liquidity in the euro area [ECB 2017].

The possibilities of avoiding penalty interest are therefore limited. To reduce the loss of profits due to the penalties, the only remaining possibility is to pass on the penalty interest to the bank customers. In addition to higher account management fees, negative interest on deposits ($i_E < 0$) would be an alternative. The following sections deal with this possibility.

3 Theoretical analysis based on game theory

3.1 Symmetric scenario

The focus of the further explanations is exclusively on QE. Without any loss of quality of the model results, the following section abstracts from minimum reserve requirements and cash withdrawals. It is assumed that household 1 sells securities to the central bank via Bank A and household 2 via Bank B. Thus, both EL and DD incur exchange costs of 1,000 € each, which is assumed to be a perfect bank deposit market, and we neglect exchange costs incurred by a private household when changing commercial banks. Thus, two commercial banks are considered which, in their initial situation, set a deposit rate of, for example, zero for their customers. Both banks can charge negative deposit interest (active strategy) or leave the deposit interest at zero (passive strategy). If negative deposit interest is charged, it corresponds to the penalty interest rate of the central bank in the amount of $i_E = -0.5$.

It was also assumed that bank's customers could not evade and had to leave their financial assets in the commercial banking sector. Thus, it is assumed that the costs of withdrawing and storing assets in the form of cash are prohibitively high. The amount of deposits held at Bank A or Bank B depends on the interest rate decision of both banks.

Tables 1 and 2 summarize the impact on the investment behavior of customers and the profits of the banks in each strategy combination:

- If both commercial banks adopt a passive strategy and leave the interest rate on deposits at 0%, there will be no reallocation of deposits. Both commercial banks pay a penalty interest of 5 € to the central bank.
- If both commercial banks charge a negative deposit rate, customers have no incentive to change their bank and will leave the money with their respective institutions. From the banks' point of view, the penalty payments to the ECB correspond to the income from the customers' negative deposit rates. The profits are then 0 €.
- If Bank A opts for an active strategy and passes on the negative interest rate, but Bank B opts for a passive strategy, household 1 will liquidate its deposits with Bank A and invest them with Bank B. Bank A loses its deposits, and Bank B holds 2,000 €. However, this restructuring of deposits is also associated with a change in excess liquidity. As a result of the restructuring of the deposits of the budget, commercial Bank A must transfer central bank money in the amount of 1,000 € to Bank B.

Table 1. Deposits with Bank A or Bank B (figures in €)

		Bank B	
		Active	**Passive**
Bank A	Active	1,000/**1,000**	0/**2,000**
	Passive	2,000/**0**	1,000/**1,000**

Table 2. Pay-off matrix for Bank A or Bank B (figures in €)

		Bank B	
		Active	**Passive**
Bank A	Active	0/**0**	0/**−10**
	Passive	−10/**0**	−5/**−5**

Bank A thus loses its excess liquidity and no longer has to pay penalty interest. Bank B now has excess liquidity of 2,000 € and has to pay a penalty interest of 10 €. Since Bank B does not pass on the penalty interest to its customers, its profit is **–10 €**.

- Since the game is symmetrical, if Bank B charges a negative interest rate and Bank A leaves the interest rate at zero, the exact opposite happens.

Interestingly, the active bank can generate a **negative external effect** for the passive bank: *The interest rate adjustment of the active bank decreases the profit for the passive bank!* This effect will be discussed further below.

First, it should be examined whether there is a dominant strategy for Bank A:

- If Bank B chooses the active strategy, the best response from Bank A is to choose an active strategy as well.
- However, if Bank B chooses a passive strategy, the best response from Bank A is also to choose an active strategy.
- Regardless of which strategy Bank B chooses, the active strategy is always the best answer for Bank A. The active strategy is therefore a dominant strategy.

Since the game is symmetrical, the same considerations apply to Bank B. Bank B also has the dominant (active) strategy. This means that both banks choose an active strategy and pass on the negative interest to their customers. The strategy combination (active, active) therefore also represents the Nash equilibrium. No player has an incentive to rethink his strategy so that the opponent sticks to his strategy.

After several smaller cooperative banks such as Volks- und Raiffeisenbanken and savings banks had already implemented a negative interest rate, the decision of Comdirect Bank, which was the first major online bank to implement penalty interest rates, hit the headlines in December 2019 [Eßlinger, 2019]. In an interview, the managing director of Verivox – a major internet portal for comparing conditions – said: *"The dam broke. At the latest when customers start to move deposits on a large scale, it will become more difficult for banks to escape the trend towards negative interest rates."* [Eßlinger, 2019]. This is the case because the negative external effect described above is generated by the shifting of funds.

3.2 Impact of the number of banks

In the theoretical case outlined above, only two banks operate. What would change if the number of banks was increased to n = 100, for example? The higher the number of banks, the lower the negative external

effect that a bank that introduces the negative interest rate would have. If only one bank introduces a negative interest rate, the deposit volume for all 99 passive banks changes by only slightly more than ten monetary units, or 1000/99 monetary units to be precise. The larger the number of banks in the market the lower the negative externality that a bank can generate by changing its strategy. Thus the strategic effect is smaller, and the probability of a domino effect decreases.

3.3 Consideration of transaction costs

Of course, the relationships described above are only valid under the explicit and implicit assumptions made. An implicit assumption was, for example, that customers always switch completely to the bank that offers a higher interest rate. To be more precise, it was assumed that customers would immediately withdraw their money completely from a bank if the bank established a negative interest rate and there was another bank in the market that did not make this change of strategy.

We now assume that the exchange costs are greater than 5 € for a private bank customer. In this case, household 1 will not switch to Bank B if Bank A charges a negative deposit rate of −0,5%.

For the distribution of deposits and profits then follows:

As shown in Table 3, deposits with a bank always amount to 1,000 € regardless of the strategies. Table 4 shows t also follows that both banks have to pay 5 € penalty interest to the ECB in each scenario. If they do not charge negative deposit interest, their profits are always −5 €. If they charge a negative deposit rate, then their profits are zero.

We recognize that even taking into account switching costs, the active strategy combination represents the balance in dominant strategies.

However, it is also clear that the extent of the strategic effect is decisively influenced by the switching behavior of customers: If customers always stay with their traditional house bank because of excessively high switching costs, no negative externality occurs. For example, if Bank A introduces a negative interest rate, no customers migrate to Bank B, and Bank B's profit does not fall.

3.4 Asymmetric scenario

In this section, the original base case scenario is used again. In the following, however, it was assumed that the two banks were of different sizes or that Bank A's deposit surplus was higher than Bank B's. In the scenario in which both banks chose a passive strategy, Bank A had 1,500 € and Bank B 500 € as deposit volumes. The corresponding payouts are also included in brackets in Table 5.

Table 3. Deposits with Bank A or Bank B (figures in €)

		Bank B	
		Active	**Passive**
Bank A	Active	1,000/**1,000**	1,000/**1,000**
	Passive	1,000/**1,000**	1,000/**1,000**

Table 4. Pay-off matrix for Bank A or Bank B (figures in €)

		Bank B	
		Active	**Passive**
Bank A	Active	0/**0**	0/**−5**
	Passive	−5/**0**	−5/**−5**

Table 5. Asymmetry scenario (figures in €)

		Bank B	
		Active	**Passive**
Bank A	Active	1,500/**500** (0/**0**)	0/**2,000** (0/**−10**)
	Passive	2,000/**0** (−10/**0**)	1,500/**500** (−7.5/**−2.5**)

Now two effects become clear:

- First, Bank A has greater pressure to change its passive strategy and adopt an active strategy.
- On the other hand, the asymmetric modeling of the banks also results in external effects of varying magnitude: If a large bank adapts its strategy and switches from passive to active, it generates a larger external effect than a small bank.

In practice, this means that the pressure is greatest at those institutions that have a relatively high liability overhang. In Germany, this generally applies to the Volks- and Raiffeisenbanks and the savings bank sector. On the other hand, it is clear that if a small institution adapts its strategy, the external effect is small. Even if already some smaller regional banks pass on the negative interest rate, this does not necessarily mean that all banks will change their strategy. This is the case because small institutions generate only a small negative external effect.

3.5 Sequential game

Until now, it has been implicitly assumed that the game is simultaneous and that both banks make their strategy choices at the same time. In reality, however, it is more likely that the interest rate decisions of banks will not be taken at the same time, but at different times.

Therefore, the theoretical analysis is now to be made somewhat more realistic. It is assumed that Bank A must first make an interest rate decision and that Bank B can then react to Bank A's action. Otherwise, all assumptions of the base scenario remain valid. The question now is whether a different result results than with simultaneous decisions. It is known from game theory that equilibrium in dominant strategy with simultaneous decisions is also a subgame perfect equilibrium in sequential games. This is shown in the following.

The game is solved by the method of backward induction: Bank A must form expectations about how Bank B will behave in the future.

- If Bank A played the active strategy in the first turn, Bank B must decide between the payouts **active (0) or passive (−10)**. These payouts are high- lighted in bold in the upper part of the game tree in Figure 1. This means that Bank B will choose an active strategy if Bank A would have chosen an active strategy before. Bank A takes this into account when making its decision.
- If, on the other hand, Bank A played the passive strategy in the first turn, Bank B must decide between the payouts **active (0) or passive (−5)**, which are shown in Fig. 1 in the lower part of the game tree. This means that Bank B will choose an active strategy if Bank A would have chosen an active strategy before. Bank A also takes this into account when making its decision.

These considerations make it clear once again: regardless of how Bank A decides on the first move, Bank B will always choose the active strategy.

- If Bank A chooses a passive strategy at the first level, Bank B chooses an active strategy and Bank A makes a loss of –10.
- However, if Bank A chooses an active strategy at the first level, Bank B also chooses an active strategy and Bank A makes a zero payout.

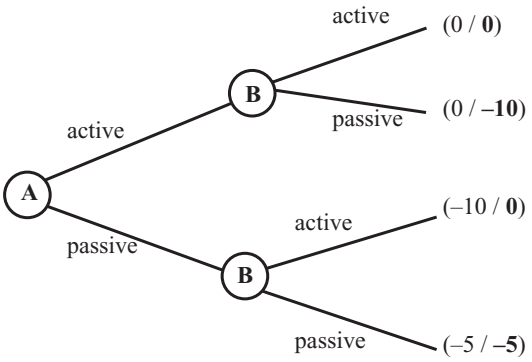

Figure 1. Game tree of a sequential game.

Bank A will therefore also choose an active strategy. It can be seen that the result from the base scenario is robust compared to the assumption of a simultaneous game and that the same outcome is achieved.

4 Conclusion and outlook

According to the monthly report of the Deutsche Bundesbank [2019c], 23% of banks are already charging negative interest on current or call money accounts. For September 2019, they reported a "negative volume-weighted average interest rate" on demand deposits. How will this trend develop in the future? An important aspect is of course the future interest rate policy of the central bank. If the central bank reduces the deposit rate of commercial banks for balances with the central bank even further into negative territory, the losses will increase if the banks stick to their passive strategy and do not pass on the negative interest rate to their customers. Thus, the further the central bank lowers the interest rate level the greater the incentive to change strategy.

In the examples above we have assumed that the commercial banks, as part of their active strategy, pass on the negative deposit rate to their customers at a ratio of 1:1 and thus implement an interest rate of i = –0.5%. This assumption can be justified if there are no switching costs and the banking market follows a Bertrand competition.

To protect themselves from the negative external effects outlined above, another strategy option for commercial banks is to demand the negative interest rate only from new customers. This does not scare off the existing customers, but it does create a barrier to deter customers who are willing to switch.

Another (creative) option that banks have come up with to avoid a negative interest rate is to introduce fees for overnight deposit accounts. The difference, in our opinion, is that a negative interest rate could continue to cause damage to the bank's image. Due to the custodian fees, it is expected that this image damage will not occur.

Our paper contributes to the literature which analyzes the interrelationship between the banking and the private sector. We can identify factors that increase or decrease the incentives for the private banking sector to pass on the negative rates to its customers. Our paper has its limitations because it only analyzes this issue in a theoretical framework. Therefore, future research should focus on the hypotheses derived by this model and should try to test the implications empirically.

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