Applied Economics and Finance
Vol. 8, No. 1; January 2021
ISSN 2332-7294 E-ISSN 2332-7308
Published by Redfame Publishing
URL: http://aef.redfame.com

A Simple Model of Interbank Trading with Tiered Remuneration

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The views expressed in this paper are those of the author and should not be interpreted as those of the Bank of Japan or other institutions the author has worked for.

Received: September 21, 2020 Accepted: December 26, 2020 Available online: December 29, 2020

doi:10.11114/aef.v8i1.5023 URL: https://doi.org/10.11114/aef.v8i1.5023

Abstract

A negative interest rate policy is often accompanied by tiered remuneration, which allows exemption from negative rates. This study proposes a basic model of interest rates in an interbank market with a tiering system. The results largely mirror actual market developments in late 2019, when the European Central Bank introduced the tiering system and the Switzerland National Bank modified it.

JEL codes: E43, E52, E58

Keywords: negative interest rate, interbank market, tiered remuneration

1. Introduction

The central banks that have imposed negative interest rates have recently either introduced a tiering system or modified the existing ones, such that it exempts the burden of negative interest rate up to a predefined limit. For instance, Danmarks Nationalbank, the central bank of Denmark, has been using negative interest rates with a tiering system for more than 5 years and reduced the policy rate by 10 bps to -0.75% in September 2019. The European Central Bank (ECB), following a 10-bps rate cut to -0.50% in September 2019, introduced a two-tier system in the next month. Swiss National Bank modified its tiering system by increasing the exemption threshold for banks in November 2019.

There are several benefits to tiering. First, it mitigates the cost burden of a negative interest rate for financial institutions. Second, it helps increase the interbank market trading activity, which is a result of the arbitrage opportunities arising from the differences in remuneration rates. For example, Bank A, which has exceeded the allocated exemption amount, may want to lend cash in the market if the market rate is higher than the negative rates charged by the central bank. At the same time, bank B, which has not reached the upper limit of the exemption amount, will borrow cash from the market, provided that the market rate is below zero. However, this arbitrage activity may lead to a negative effect by increasing the market rate to a level higher than in a market without a tiering system. In other words, the tiering system weakens the transmission of the negative remuneration rate to the interbank market.

This study formulates a basic model of an interbank market with tiering remuneration and describes three effects: burden mitigation, trading volume, and rate formation. The simplicity of the model allows it to be tested using actual market data, but this simplicity also means that the model assumes high liquidity across all banks and negligible payment shocks. If the model were to include shocks, such as the central bank lending mentioned in Poole's (1968) framework, the market rate would become the risk-weighted average of the central bank's lending and deposit facility rate (Bindseil, 2004). However, the market rate in the proposed model will be linked to the exemption size.

Other authors have also conducted research on this subject in recent years. For example, Boutros and Witmer (2017) introduced a theoretical model with a tiering remuneration system but did not test actual market data. A year later, Afonso, Armenter, and Lester (2018) successfully tested a model using market data and compared their model of the United States Federal Funds market with individual bank-level data.

2. Model and Equilibrium

2.1 Setup in the Morning

Bank i has a profile of excess liquidity x_i and a cost regarding trade transactions (except for the trading rate), $c_i\%$.

We assume uniform and mutually independent distributions of $x_i \sim (0,1)$ and $c_i \sim (0,1)$, for simplicity.

2.2 Tiering Remuneration in the Afternoon

Bank i follows the following remuneration schedule: 0% is applied to the reserve position in the afternoon, x_{ai} up to the individual limit of exemption u_i, and -1% is applied to the exceeding amount. We assume that u_i is the same for all institutions, that is, $u_i = u$.

The share of the aggregated amount of the upper limit of exemption relative to the aggregated excess liquidity, the exemption share (E), is calculated as:

$$E = \int_i u_i \,\mathrm{d}i \Big/ \int_i x_i \,\mathrm{d}i = 2u. \tag{1}$$

2.3 Trading Decision During the Day

Bank i decides to either lend l_i, borrow b_i, or do nothing. The decision is made by comparing market rate $-r\%$, associated cost $c_i\%$, and remuneration rate 0% for the exemption amount and -1% for the exceeding amount:

$$x_{ai} = \begin{cases} x_i - l_i, x_i > u_i \text{ and } -r - c_i - (-1) > 0 \\ x_i + b_i, u_i > x_i \text{ and } 0 - (-r) - c_i > 0 \\ x_i, \text{otherwise} \end{cases}. \tag{2}$$

The concept modeled in (2) is that bank i $(x_i > u_i)$ will lend money if the income from lending $-r$ minus cost c_i minus the opportunity cost to receive remuneration -1 is positive. Similarly, bank i $(u_i > x_i)$ will borrow money if the income from borrowing r minus cost c_i is positive.

2.4 Equilibrium Market Rate

Market rate $-r^*$ should be decided so that it balances the aggregated lending and borrowing needs. This amount is known as trading volume V:

$$V = \int_i l_i \,\mathrm{d}i = \int_i b_i \,\mathrm{d}i, \tag{3}$$

$$V = \int_i \max(x_i - u_i, 0) \cdot \mathbf{1}_{\{-r^* - c_i + 1 > 0\}} \,\mathrm{d}i = \int_i \max(u_i - x_i, 0) \cdot \mathbf{1}_{\{r^* - c_i > 0\}} \,\mathrm{d}i, \tag{4}$$

$$V = \frac{1}{2}(1-u)^2(1-r^*) = \frac{1}{2}u^2 r^*. \tag{5}$$

Using equation (5), we have:

$$-r^* = \frac{-(1-u)^2}{u^2 + (1-u)^2}, \tag{6}$$

$$V = \frac{1}{2}\frac{u^2(1-u)^2}{u^2 + (1-u)^2}. \tag{7}$$

Further, there are some banks that have reserves exceeding u_i but avoid lending because of the associated costs. Then, the share of the aggregated amounts to which the negative rate is to be applied relative to the aggregated excess liquidity, and the negative remuneration share (N) is calculated as:

$$N = \int_i \max(x_i - u, 0) \cdot \mathbf{1}_{\{-r^* - c_i + 1 \leq 0\}} \,\mathrm{d}i \Big/ \int_i x_i \,\mathrm{d}i = \frac{(1-u)^4}{u^2 + (1-u)^2} \tag{8}$$

3. Testing with Actual Data

Figure 1 shows a plot of the average data for the third and fourth quarters of 2019 of E plotted against the observed market rate for four currencies with tiering systems. The observed rate is the overnight or next day rate, standardized by dividing it by the degree of negative remuneration. The bold line shows the theoretical $-r^*$ using (6). Key changes in the negative interest rate policy and tiering, as mentioned in Section 1, were made between the third and fourth quarters of 2019. Consequently, the relative positions of the two points for each currency represent the impact of the changes in the market rate. The effect is pronounced for the euro (EUR) and Swiss franc (CHF), as we exclude the term before these changes in the calculation of the average for the fourth quarter.

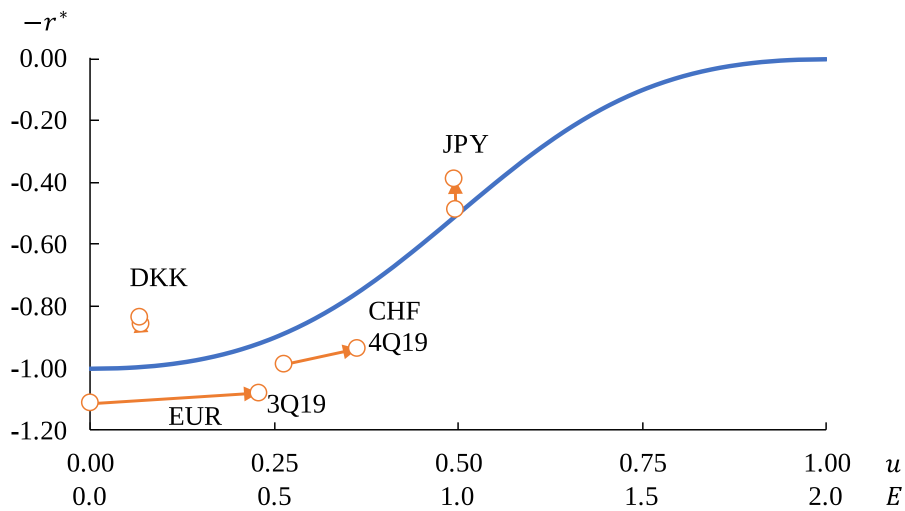

Figure 1. Relationship between E and the observed market rate

Sources: NASDAQ, SIX Swiss Exchange, Danmarks Nationalbank, BoJ, SNB

Despite the oversimplification, the actual data do not differ significantly from the model results. The slope of CHF is steeper than that of the EUR and this is precisely the model's implication: as E approaches 1.0, the sensitivity of the market rate to E increases.

Some deviation from the theoretical rate can be explained by the characteristics of the selected short-term rates. For example, a collateralized rate—SARON (Swiss Average Rate Overnight)—is used for the CHF, while an unsecured rate—Denmark T/N (Tomorrow/Next)—is used for the Danish krone (DKK). Therefore, the differences in the model can be interpreted as risk premium and collateral demand. For the EUR, the overnight rate selected here is the benchmark rate, €STR, which is an unsecured rate composed of the deposit rate offered by major banks. Hence, it tends to be lower than the negative remuneration rate set by the central bank. If we can use the EONIA, the lending rate offered by major banks, the positions of the points are above the model estimations. However, the calculation method of the EONIA changed in October 2019 and now only reflects the subsequent development of the €STR.

Another interesting observation is the relatively vertical line for the Japanese yen (JPY). The rate used here is the unsecured rate, TONAR, and the observed rate is volatile around -0.5. One reason for this may be that E is as high as 0.99 and this situation may appear to preserve the market function. Equation (7) explains how the market trading activity, V, is maximized at around $E = 1.0$; this is further proven by the directional changes in 2019 for both the EUR and CHF, as they highlight high sensitivity of the market rate to E.

Equation (8) predicts that the negative remuneration share for the JPY is approximately 13%; in reality, it is close to 5%. This may be linked to the reserve neutral exemption scheme of Japan. The exemption limit in Japan is based on the actual reserve size in 2015 and the amount of the funding from the central bank, unlike for the EUR and CHF (in the eurozone and Switzerland, respectively), where the exemption amount is defined by the multiple of the reserve requirements. Therefore, the reserve position relative to the exemption is distributed more evenly, such that $x_i \sim (0.3, 0.7)$ compared to the default setup of the model $x_i \sim (0,1)$. As a result, the slope of the curve modeled in (7) becomes roughly 2.5 times the original sensitivity.

4. Conclusions

This study proposes a simplistic model operating in an interbank market with tiering remuneration. One of the limitations of the model, rather an effect of the oversimplification, is that the model does not consider the actual demand of cash in the interbank market. The original purpose of interbank trade is to adjust the reserve position by considering payment shocks, fulfilling reserve requirements and real funding needs for investing activity. In the case of Denmark, where the ratio of the central bank's balance sheet to the GDP is relatively small compared to other jurisdictions, the actual requirement of the funding is not negligible in the formation of the market rate. In Switzerland, where the negative remuneration is calculated daily, the payment shock of each day plays an important role.

This study has given priority to simplicity to better understand the mechanism of the tiering system and its impact on the interbank market. The prediction of actual market data may not be perfect under the model but is acceptable in some cases. The author believes that the proposed model offers a good balance between simplicity and efficiency for a practical approach.

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