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The Reversal Interest Rate
A Critical Review

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Abstract

This paper reviews the analysis in Brunnermeier and Koby (2018), showing that lower monetary policy rates can only lead to lower bank lending if there is a binding capital constraint and the bank is a net investor in debt securities, a condition typically satisfied by high deposit banks. It next notes that BK's capital constraint features the future value of the bank's capital, not the current value as in standard regulation. Then, it sets up an alternative model with a standard capital requirement in which profitability matters because bank capital is endogenously provided by shareholders, showing that in this model there is no reversal rate.

JEL Codes: E52, G21, L13.

Keywords: Monetary policy, reversal rate, negative interest rates, bank profitability, bank market power, capital requirements.

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"The 'reversal interest rate' is the rate at which accommodative monetary policy reverses its intended effect and becomes contractionary for lending."

Brunnermeier and Koby (2018)

1 Introduction

The paper "The Reversal Interest Rate" by Brunnermeier and Koby (2018), henceforth BK, presents a theoretical model to characterize the effective lower bound for monetary policy. In particular, they show how a reduction in monetary policy rates below a threshold "reversal rate" leads to a reduction in the value of banks, which via a capital constraint leads to a contraction in bank lending. They first present the result in a partial equilibrium model of a local monopoly bank,[1] and then in a New Keynesian macroeconomic model. This paper presents a critical review of BK's results, focusing on their partial equilibrium model.

It should be noted that in their model a reduction in the policy rate has two opposite effects on bank capital. On the one hand, there is a positive effect due to the increase in the value of long-term mark-to-market assets. On the other hand, there is a negative effect on profitability. The negative profitability effect is key for the existence of a reversal rate, while the positive revaluation effect works in the opposite direction. Since the revaluation effect weakens BK's result, and it is ad hoc because in their model banks do not have such assets in their balance sheet, I will focus my critique on the profitability channel.

BK's setup features a local monopoly bank with a given amount of equity capital that faces an upward sloping supply of deposits and a downward sloping demand for loans, and can also invest in debt securities whose interest rate is taken to be the monetary policy rate set by the central bank. BK assume that the bank's maximization problem is subject to two financial frictions, a capital constraint and a liquidity constraint.

The liquidity constraint requires the bank to invest a fraction of their deposits in (liquid) debt securities. This constraint plays a key role in their results. In particular, a binding liquidity constraint makes lending equal to the sum of a proportion of its deposits (those not

[1] A local monopoly bank is a bank that is the single provider of loans and deposits in a local market, but it is a perfect competitor in an economy-wide securities markets.

invested in debt securities) plus the exogenous capital. This means what happens to lending following a reduction in the policy rate is driven by what happens to deposit taking. I show that if the liquidity constraint is binding, lower policy rates lead to lower deposits and, hence, lower lending. However, this is not the narrative of the reversal rate in BK, which is linked to the effect of lower rates on bank profitability. For this reason, I will focus my critique on the effect of the policy rate on lending in the presence of only a capital constraint.

The capital constraint in BK requires the bank to back a fraction of its lending with equity capital. They argue that this constraint captures “economic and regulatory factors.” However, their constraint features the future value of the bank’s capital, not the current value as it should be if it were to capture a regulatory capital requirement. Moreover, it is also the case that their constraint is not implied by a standard forward-looking collateral constraint.

At any rate, I review in Section 2 the possible existence of a reversal rate in the presence of BK’s capital constraint, showing the following results. First, if the capital constraint is not binding lower policy rates always lead to higher lending. Second, if the capital constraint is binding a reversal rate exists if and only if the bank is a net investor in debt securities, a condition that is typically satisfied by high deposit banks (those with more deposits than loans). Third, there is no single reversal rate, since whenever it exists it depends on bank-specific characteristics, in particular their relative advantage in raising deposits versus granting loans.

It should be noted that BK’s specification of the capital constraint has a simple justification: no reversal would exist if lending is constrained by the current (exogenous) value of the bank’s capital, since the constraint would just set an upper bound on lending. However, this misses their intuition that bank profitability should matter for lending, because if shareholders do not get an adequate return from their investment they might not want to contribute their capital to the bank or shift it to other uses.

To capture this intuition, I consider in Section 3 a model in which the bank’s equity capital is not exogenous, but it is endogenously provided by shareholders that demand a return on their investment that incorporates a positive excess cost of capital. In this model, there is a profitability constraint that requires that the future value of the bank's capital be greater than or equal to the opportunity cost of the funds provided by shareholders. The future value of the bank's capital is driven by two components: profits from lending, equal to the spread between the loan rate and the policy rate multiplied by the total amount of loans, and profits from deposit taking, equal to the spread between the policy rate and deposit rate multiplied by the total amount of deposits. While the former are always positive, the latter can be negative when (i) the policy rate becomes negative and (ii) there is a zero lower bound on deposit rates.[2]

The question is: Is it possible to get a reversal rate when the losses from deposit taking become very large? Unfortunately, the answer is no: In this setup the profitability constraint does not bring about a reversal rate, except in the extreme form of banks closing down altogether when shareholders do not get the required return from their investment. The intuition for this result is straightforward. Lower policy rates always increase the bank's profits from lending, since they reduce the weighted average cost of deposits and capital. For the same reason, with a downward sloping demand for loans, they increase bank lending. At some point, the losses from deposit taking may exceed the profits from lending, but until we get to that point the bank will continue to expand its lending, since it is what maximizes its profits.

This paper is closely related to the growing literature on the transmission of monetary policy when banks have market power; see, for example, Corbae and Levine (2018), Drechsler et al. (2017), Martinez-Miera and Repullo (2020), and Wang et al. (2019). It is also related to the recent empirical literature on the effects of negative policy rates. In particular, Altavilla et al. (2019), Bottero et al. (2019), Demiralp et al. (2019), and Lopez et al. (2020), using different datasets and methodologies, show that negative interest rates have expansionary effects on lending, while Heider at al. (2019) show that the effects are more significant for banks with smaller reliance on deposit funding.

In terms of theme, the closest reference is Eggertsson et al. (2019). They empirically examine with Swedish data the effect of negative policy rates, and then they construct a

[2] It should be noted that BK do not explicitly consider negative policy rates.

partial equilibrium model that is parametrized using the empirical results, which is later embedded into a New Keynesian macroeconomic model. A key ingredient of their model is the existence of a lower bound on the deposit rate that banks can offer. The model does not explicitly incorporate banks' market power, so the spreads between the loan rate and the policy rate and the policy rate and deposit rate are determined by various convex cost functions corresponding to different aspects of the intermediation process. They show that the effect of negative policy rates on bank profits is a sufficient statistic for the effect on bank lending. However, it is difficult to see what features of the model are driving the result.

Another closely related paper is Ulate-Campos (2019). He constructs a New Keynesian macroeconomic model in which banks intermediate the transmission of monetary policy. He assumes that banks have market power in both loans and deposits, and that there is a zero lower bound on deposit rates. His main result is a quantitative estimation of the reduced impact of policy rates on lending when the policy rate is close or below zero, although the effect is still positive and significant, so there is no reversal rate.

The remainder of the paper is structured as follows. Section 2 presents my critical review of BK's model, which features a given initial level of capital and a capital constraint in terms of the future value of a bank's capital. Section 3 presents the alternative model in which bank capital is endogenously provided by shareholders and there is a standard capital requirement based on the current value of a bank's capital. Section 4 concludes.

2 A Review of BK's Model

Consider an economy with two dates ($t = 0, 1$) in which a bank with an initial level of equity capital K raises deposits D and invests in (safe) loans L and (safe) debt securities S, so its balance sheet identity is

$$L + S = D + K. \tag{1}$$

The bank is a *local monopoly* facing an upward sloping *supply of deposits* $D(r_D)$ and a downward sloping *demand for loans* $L(r_L)$, where r_D and r_L denote, respectively, the deposit and the loan rate set by the bank. The interest rate of debt securities r is exogenous and taken to be equal to the monetary policy rate set by the central bank.[3]

The bank chooses r_D and r_L to maximize its equity value at $t = 1$ given by

$$V = (1 + r_L)L(r_L) + (1 + r)S - (1 + r_D)D(r_D). \tag{2}$$

Solving for S in the balance sheet identity (1) and substituting it into (2) gives

$$V = (r_L - r)L(r_L) + (r - r_D)D(r_D) + (1 + r)K. \tag{3}$$

The term $(r_L - r)L(r_L)$ captures the *profits from lending*, which are equal to the spread between the loan rate r_L and the policy rate r multiplied by the total amount of loans $L(r_L)$. The term $(r - r_D)D(r_D)$ captures the *profits from deposit taking*, which are equal to the spread between the policy rate r and deposit rate r_D multiplied by the total amount of deposits $D(r_D)$. Finally, the term $(1 + r)K$ corresponds to the gross return of investing the bank's capital in debt securities.[4]

BK assume that the bank's maximization problem is subject to two "financial frictions." The first one is a *capital constraint* of the form

$$\gamma L(r_L) \leq V. \tag{4}$$

The second is a *liquidity constraint* of the form

$$\lambda D(r_D) \leq S. \tag{5}$$

According to BK, the capital constraint captures "economic and regulatory factors," while the liquidity constraint captures "the fact that banks need sufficient and easily accessible funds to avoid run risk."

The liquidity constraint (5) could be related to the regulation of the Basel Committee on Banking Supervision, in particular the liquidity coverage ratio of Basel III.[5] In contrast, the

[3] Alternatively, S could be interpreted as the amount of interbank lending, and r the interbank rate, equal to the policy rate set by the central bank. Eggertsson et al. (2019) document that virtually there is full pass-through of negative policy rates to money market rates.

[4] Using (3) as the bank's objective function requires an additional assumption, namely that debt holdings S are nonnegative. However, this assumption is trivially satisfied when the bank's maximization problem is subject to the liquidity constraint (5) below.

[5] See Basel Committee on Banking Supervision (2013).

capital constraint (4) cannot, since the right-hand-side of the constraint features the bank's future value of equity V, not the current (accounting) value K which characterizes the Basel capital requirements. I will come back to this below.

There is an additional ingredient in BK's model that needs to be discussed, namely the assumption that the initial level of equity capital K is an increasing function of the policy rate r. This is supposed to capture the fact that "the value of banks' past assets and liabilities might change after monetary policy changes its stance. This revaluation can take the form of capital gains on mark-to-market assets, but include in spirit any asset revaluation, including, for example, changes in loan-losses provisions." This is an ad hoc assumption that is not derived from, say, capital gains on mark-to-market assets, since the bank starts with no such assets in its balance sheet. Moreover, the positive effect of lower rates on the current value of equity K leads, by equation (3), to an increase in the future value of equity V, making it more difficult to get a reversal rate. For this reason, in what follows I will simply assume that K is a constant parameter.

To analyze BK's key reversal result it is convenient to work with the *inverse supply of deposits* $r_D(D)$ and the *inverse demand for loans* $r_L(L)$, so the bank's maximization problem is written as

$$\max_{(L,D)} V = [r_L(L) - r]L + [r - r_D(D)]D + (1 + r)K \tag{6}$$

subject to the capital constraint

$$\gamma L \leq V, \tag{7}$$

and the liquidity constraint

$$\lambda D \leq S. \tag{8}$$

The liquidity constraint (8) plays a key role in BK's model. To see this, note that if this constraint is binding (and for simplicity the capital constraint is not) the bank's balance sheet identity (1) implies

$$L = (1 - \lambda)D + K. \tag{9}$$

Thus, total lending has to be equal to the fraction of deposits that are not tied to investing in debt securities plus the equity capital that has no such restriction. Substituting D from

(9) into the bank's objective function (6), and differentiating with respect to L yields the first-order condition

$$[r_L(L) - r + r'_L(L)L] + [r - r_D(D) - r'_D(D)D](1-\lambda)^{-1} = 0. \quad (10)$$

Assuming that the second-order condition

$$[2r'_L(L) + r''_L(L)L] - [2r'_D(D) + r''_D(D)D](1-\lambda)^{-2} < 0 \quad (11)$$

is satisfied, this implies

$$\frac{dL}{dr} = \frac{1-(1-\lambda)^{-1}}{[2r'_L(L) + r''_L(L)L] - [2r'_D(D) + r''_D(D)D](1-\lambda)^{-2}} > 0. \quad (12)$$

Thus, a binding liquidity constraint implies that a lower policy rate r leads to lower equilibrium lending L. The intuition is that a lower r leads to a reduction in deposits D which by the balance sheet constraint (9) implies a reduction in lending L.

However, this is not the narrative of the reversal rate in BK, which is based on the idea that lower policy rates reduce the value of the bank, which via the capital constraint leads to a contraction in lending. For this reason, in what follows I will focus exclusively on the effect of interest rates on lending in the presence of the capital constraint (7).[6] I will also assume that debt holdings S are is unrestricted, so the bank can set $S < 0$, that is borrow (by issuing debt securities) at the rate r.[7]

As a benchmark, I start with the case in which the capital constraint is not binding. If S is unrestricted, lending and deposit taking are separable, so the bank will determine L by maximizing its profits from lending $[r_L(L) - r]L$ and will determine D by maximizing its profits from deposit taking $[r - r_D(D)]D$. The first-order condition that characterizes equilibrium bank lending is

$$r_L(L) - r + r'_L(L)L = 0. \quad (13)$$

[6] Notice that if the bank were able to raise market debt Z at the rate r, and assuming that this debt is not subject to the liquidity requirement (say, because it is not short-term), the balance sheet identity (1) would become $L + S = D + Z + K$, so the liquidity constraint $\lambda D \leq S$ would not be binding.

[7] Equivalently, a negative S could be interpreted as borrowing in a competitive interbank market.

Assuming that the second-order condition $2r'_L(L) + r''_L(L)L < 0$ is satisfied, this implies

$$\frac{dL}{dr} = \frac{1}{2r'_L(L) + r''_L(L)L} < 0. \tag{14}$$

Thus, *if the capital constraint is not binding, lower policy rates always lead to higher lending.* There is no reversal rate.

Consider then a situation in which the capital constraint (7) is binding, so we have

$$\gamma L > V = \max_L\{[r_L(L) - r]L\} + \max_D\{[r - r_D(D)]D\} + (1 + r)K. \tag{15}$$

In this case, bank lending will be the highest solution to the equation

$$\gamma L = [r_L(L) - r]L + \max_D\{[r - r_D(D)]D\} + (1 + r)K, \tag{16}$$

Differentiating (16) and using the envelope theorem and the balance sheet identity (1) then gives

$$\frac{dL}{dr} = \frac{D + K - L}{\gamma - [r_L(L) - r + r'_L(L)L]} = \frac{S}{\gamma - [r_L(L) - r + r'_L(L)L]}. \tag{17}$$

The denominator of this expression is positive, since otherwise increasing L would have a smaller effect on the capital requirement γL than on the profits from lending $[r_L(L) - r]L$, so L could not be the highest solution to (16). We conclude that when the capital constraint (7) is binding and $S > 0$, we have $dL/dr > 0$. Thus, in this case lower policy rates lead to lower lending. But if $S < 0$, that is if the bank is partially funding its lending with market debt, lower policy rates lead to higher lending. In other words, *a reversal rate exists if and only if the capital constraint is binding and the bank is a net investor in debt securities.*[8]

Since equity capital K is typically a small fraction of a bank's balance sheet, the case $S > 0$ essentially corresponds to high deposit banks, while the case $S < 0$ corresponds to low deposit banks.[9] This is very much in line with the empirical results in Heider et al. (2019): "The introduction of negative policy rates by the European Central Bank in mid-2014 leads

[8] Or, equivalently, the bank is a net lender in the interbank market.

[9] In thinking about the empirical counterpart of the variable S, it is important to bear in mind that "loans" and "deposits" should be taken to be assets and liabilities for which the bank has significant market power. In particular, corporate deposits that pay (possibly negative) market rates should not be counted as "deposits."

to (...) less lending by euro-area banks with a greater reliance on deposit funding." It is also consistent with the results in Eggertsson et al. (2019) showing that Swedish banks that rely more heavily on deposit financing experienced lower credit growth after the policy rate became negative.

The conclusion that follows from these results is that (i) *there is no single reversal rate, since it depends on bank-specific characteristics*, and (ii) *a reversal rate does not exist for low deposit banks.*

However, one important concern about these results is the nature of the capital constraint. As noted above, the right-hand-side of (7) features the bank's future value of equity V, not the current value K, as it should be if it is to capture a regulatory constraint. Moreover, the constraint (7) does not correspond to a standard forward-looking collateral constraint, which in the context of this model (and for the case $S > 0$) would take the form

$$[1 + r_D(D)]D \leq (1 - \gamma) \{[1 + r_L(L)]L + (1 + r)S\} . \tag{18}$$

According to this expression, the bank's future liabilities should be smaller than a fraction $1 - \gamma$ of its future assets. Using (2) this expression may be rewritten as

$$\gamma \{[(1 + r_L(L)]L + (1 + r)S\} \leq V, \tag{19}$$

which is very different from BK's capital constraint (7). For these reasons, in the next section I will examine the possible existence of a reversal rate in a model with a capital constraint based on the current value K of a bank's equity capital.

3 An Alternative Model

Consider an economy with two dates ($t = 0, 1$) in which a local monopoly bank faces an upward sloping *supply of deposits* $D(r_D)$ and a downward sloping *demand for loans* $L(r_L)$, where r_D and r_L denote, respectively, the deposit and the loan rate set by the bank. There is a competitive *interbank market* in which the bank can lend ($S > 0$) or borrow ($S < 0$) at the policy rate r set by the central bank.[10]

[10] Thus, for the reasons explained above, I am assuming that the bank is not subject to a liquidity constraint, so S is unrestricted.

Suppose first that the bank has an initial level of equity capital K, as in BK, and there is a capital requirement of the standard form

$$\gamma L \leq K, \tag{20}$$

If the requirement were not binding, we would be in the same situation as in BK's model without constraints, in which case by (14) we have $dL/dr < 0$, so no reversal rate. However, it may be the case that when the policy rate r is sufficiently low bank lending grows so much that the capital constraint becomes binding, in which case $L = K/\gamma$ and $dL/dr = 0$, so no reversal rate either.

Thus, *the combination of an exogenous level of equity capital with a standard capital requirement makes reversal impossible.* However, this model misses BK's intuition that bank profitability should matter for lending, because if shareholders do not get an adequate return from their investment they might not want to contribute their capital to the bank or shift it to other uses, which in the presence of a capital constraint would reduce their lending.

To capture this intuition, in what follows I assume that the bank's equity capital K is not exogenous, but it is endogenously provided by bank shareholders. Moreover, following the standard assumption in the banking literature, I assume that equity is costly in that shareholders require a minimum return $r + \rho$ for their investment, where ρ is a positive excess cost of capital.

In models with endogenous equity the bank's objective function has to incorporate the opportunity cost of the funds provided by the bank's shareholders, which is $(1 + r + \rho)K$. Hence, the bank's objective function becomes

$$VN = (1 + r_L)L(r_L) + (1 + r)S - (1 + r_D)D(r_D) - (1 + r + \rho)K, \tag{21}$$

where VN is the net value of the bank. Solving for S in the balance sheet identity (1) and substituting it into (21) gives

$$VN = (r_L - r)L(r_L) + (r - r_D)D(r_D) - \rho K. \tag{22}$$

The derivative of VN with respect to K is negative, because equity is costlier than debt, which implies that the capital requirement (20) will always be binding. Hence, we can substitute $K = \gamma L(r_L)$ into (22), which gives

$$VN = (r_L - r - \gamma\rho)L(r_L) + (r - r_D)D(r_D). \tag{23}$$

As before, I can rewrite the bank's maximization problem using the inverse supply of deposits $r_D(D)$ and the inverse demand for loans $r_L(L)$, which gives

$$\max_{(L,D)} VN = [r_L(L) - r - \gamma\rho]L + [r - r_D(D)]D. \tag{24}$$

Bank lending is characterized by the first-order condition

$$r_L(L) - r - \rho\gamma + r_L'(L)L = 0. \tag{25}$$

Assuming that the second-order condition $2r_L'(L) + r_L''(L)L < 0$ is satisfied, this implies

$$\frac{dL}{dr} = \frac{1}{2r_L'(L) + r_L''(L)L} < 0. \tag{26}$$

Hence, *in this setup lower rates always lead to higher lending*: no reversal rate either.

This result poses the following question: Why is bank profitability irrelevant? In other words, what is wrong with BK's intuition?

To answer this question note that, by (21), the gross value of the bank at $t = 1$ can be written as

$$V = (1 + r_L)L(r_L) + (1 + r)S - (1 + r_D)D(r_D) = VN + (1 + r + \rho)K. \tag{27}$$

The *profitability constraint* will be satisfied if and only if the future value of the bank V is greater than or equal to the opportunity cost of the funds initially provided by the shareholders, which is $(1 + r + \rho)K$. Hence, the constraint will be satisfied if and only the net value of the bank VN is nonnegative. The key questions are: What is the effect of the policy rate r on VN? And can VN become negative?

To answer these questions it is useful to write

$$VN(r) = \pi_L(r) + \pi_D(r), \tag{28}$$

where

$$\pi_L(r) = \max_L\{[r_L(L) - r - \gamma\rho]L\} \tag{29}$$

are the maximum profits from lending, and

$$\pi_D(r) = \max_D\{[r - r_D(D)]D\} \tag{30}$$

are the maximum profits from deposit taking.

Profits from lending $\pi_L(r)$ cannot be negative, since the bank could always set $L = 0$. Moreover, by the envelope theorem we have $\pi'_L(r) = -L < 0$, so lower policy rates increase them. In contrast, profits from deposit taking $\pi_D(r)$ can be negative when (i) the policy rate becomes negative and (ii) there is a zero lower bound on deposit rates (say, because households could move into cash). In this case we have

$$\pi_D(r) = rD_0 < 0, \tag{31}$$

where D_0 are the deposits for a zero deposit rate, assumed to be positive.[11] Moreover, in this case we have $\pi'_D(r) = D_0 > 0$, so lower policy rates further reduce profits from deposit taking.

From here it follows that

$$VN(0) = \pi_L(0) + \pi_D(0) = \pi_L(0) > 0, \tag{32}$$

so the profitability constraint is not binding for $r = 0$. Moreover, for $r < 0$ we have

$$VN'(r) = \pi'_L(r) + \pi'_D(r) = D_0 - L. \tag{33}$$

Let L_0 denote lending for $r = 0$. There are two cases to consider depending on whether $D_0 > L_0$ (a high deposit bank) or $D_0 < L_0$ (a low deposit bank).

In the case of a low deposit bank, since we have shown that $dL/dr < 0$, it follows that for $r < 0$ we have

$$VN'(r) = D_0 - L < D_0 - L_0 < 0. \tag{34}$$

This means that lower rates have a larger effect on the profits from lending than on the losses from deposit taking, so the profitability constraint will never be binding. Figure 1 illustrates this case.

[11] It is implicitly assumed that the bank cannot turn depositors away.

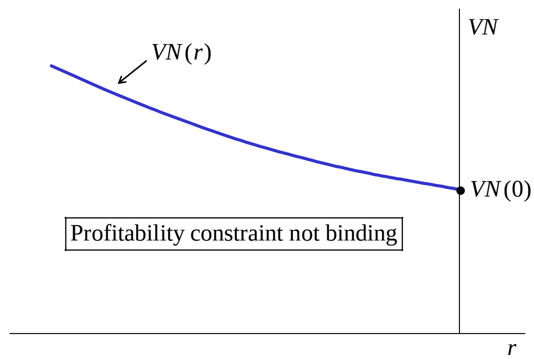

Figure 1. Net value of a low deposit bank for negative policy rates

In the case of a high deposit bank we have

$$VN'(0) = D_0 - L_0 > 0, \tag{35}$$

but since $dL/dr < 0$ the slope $VN'(r) = D_0 - L$ becomes flatter for lower policy rates. Depending on the value of $VN(0)$ and the effect of r on the slope, a critical policy rate $\underline{r}$ for which $VN(\underline{r}) = 0$ mat be reached, in which case the profitability constraint will become binding for $r < \underline{r}$, or we may have $VN(r) > 0$ for all $r < 0$ in the relevant range, in which case the profitability constraint will never be binding. Panels A and B of Figure 2 illustrate these two possible cases.[12]

[12] The different results for low and high deposit banks are in line with the results in Eggertsson et al. (2019) showing that negative policy rates can increase or decrease bank profits depending on their net exposure to negative rates.

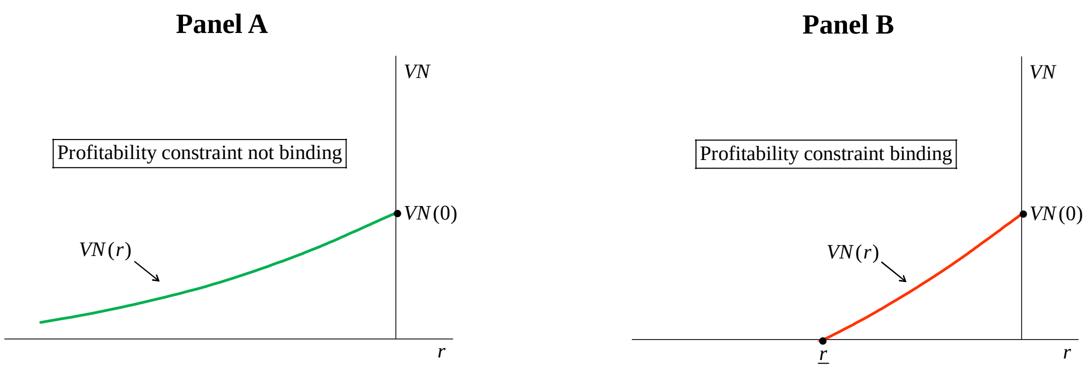

Figure 2. Net value of a high deposit bank for negative policy rates

The conclusion that follows from these results is that, in a model in which the banks' equity capital is endogenously provided by its shareholders, the profitability constraint does not bring about a reversal rate, except in the extreme form of banks closing down altogether– the case shown in Panel B of Figure 2 for policy rates below $\underline{r}$.[13]

The intuition for these results is as follows. Lower policy rates always increase the bank's profits from lending, since they reduce the weighted average cost of capital

$$(1-\gamma)r + \gamma(r+\rho) = r + \gamma\rho. \tag{36}$$

For the same reason, with a downward sloping demand for loans, they increase bank lending. At the same time, in the presence of a zero lower bound on deposit rates, lower negative policy rates increase the bank's losses from deposit taking. At some point, these losses may exceed the profits from lending, in which case bank shareholders will not get the required compensation for their capital. But notice that until we get to that point the bank will continue to expand its lending, since it is what maximizes its profits.

It should be noted that the results of this model are compatible with those in Heider et al. (2019) and Eggertsson et al. (2019), showing that lower negative rates have larger effects

[13] The critical rate $\underline{r}$ resembles the threshold rate $\underline{i}$ in Ulate-Campos (2019) at which some banks stop taking deposits.

on lending by low deposit banks, as long as these banks have a comparative advantage in lending that they are able to exploit with lower policy rates.

The profitability constraint $VN \geq 0$ may be rewritten in two interesting equivalent manners. First, define the bank's return on equity as

$$ROE = \frac{V - K}{K}. \tag{37}$$

Using (27) it follows that

$$ROE = \frac{VN}{K} + r + \rho. \tag{38}$$

Hence, $VN \geq 0$ if and only if $ROE \geq r + \rho$. That is, the profitability constraint is satisfied if and only if the bank's return on equity is greater than or equal to the bank's cost of equity capital.

Second, define the bank's current market value of equity as the discounted value of the bank at $t = 1$, where the discount rate is the shareholders' cost of capital, that is

$$M = \frac{V}{1 + r + \rho}. \tag{39}$$

Using (27) it follows that

$$M = \frac{VN}{1 + r + \rho} + K \tag{40}$$

Hence, $VN \geq 0$ if and only if $M \geq K$. That is, the profitability constraint is satisfied if and only if the bank's market to book ratio is greater than one.

The previous results raise the issue of how to explain that in the last few years many banks, especially in Europe and Japan, have shown market to book ratios below one.[14] One possible way to rationalize it in the context of the model is to assume that part of the banks' capital was contributed by some shareholders at a time when policy rates were positive, and that the arrival of negative rates, possibly below $\underline{r}$, imposes a capital loss to earlier shareholders, reducing the average market to book ratios below one, but with marginal shareholders getting the required return on the capital needed to support their increased lending. A similar argument could be constructed following an unexpected increase

[14] See, for example, Bogdanova et al. (2018) and International Monetary Fund (2018).

in capital requirements such as those in the 2010 agreement of the Basel Committee on Banking Supervision, known as Basel III.

4 Concluding Remarks

This paper has reviewed the claim in Brunnermeier and Koby (2018) that a reduction in monetary policy rates below a threshold "reversal rate" may lead to a reduction in bank lending. It shows that, in the context of their model, lower policy rates leads to lower lending if and only if there is a binding capital constraint and the bank is a net investor in debt securities, a condition typically satisfied by high deposit banks. Thus, a reversal rate may or may not exist, and when it does it depends on bank-specific characteristics, in particular their relative advantage of raising deposits versus granting loans.

However, the capital constraint in BK, which is supposed to capture "economic and regulatory factors," does not correspond to either a standard collateral constraint or a standard capital requirement. For this reason, I set up an alternative model with a standard capital requirement in which profitability matters because bank capital is endogenously provided by shareholders, showing that in this model there is no reversal rate.

The conclusion that follows from this analysis is that policy makers should not assume that lower negative rates will, at some point, be contractionary for lending. Negative rates may bring about some problems, in the banking system and the broader economy, but the expectation should be that they will increase lending.

I would like to end with a few remarks. First, I have used a setup in which the bank is a monopolist in lending and deposit taking in a local market, but has access to a competitive debt market. The local monopoly assumption simplifies the analysis, but all the results could be obtained in a setup in which several banks compete (for example, à la Cournot) in a local market and have access to a competitive debt market.

Second, in addressing the effects of profitability on bank lending it is natural to think about a process that takes place over time, with shareholders gradually reducing their capital until the capital constraint becomes binding. The alternative model in Section 3 tries to capture this process in a reduced form manner by assuming that initial bank capital is endogenously provided by bank shareholders. Still, developing dynamic models of banking that address these issues would be most welcome.

Finally, it is important to stress that partial equilibrium models like the ones presented in this paper have obvious limitations in capturing general equilibrium effects of monetary policy actions. However, they should be useful as building blocks for macroeconomic models with solid microfoundations of the banking system.

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