

Monetary Policy Implementation in a Negative Rate Environment

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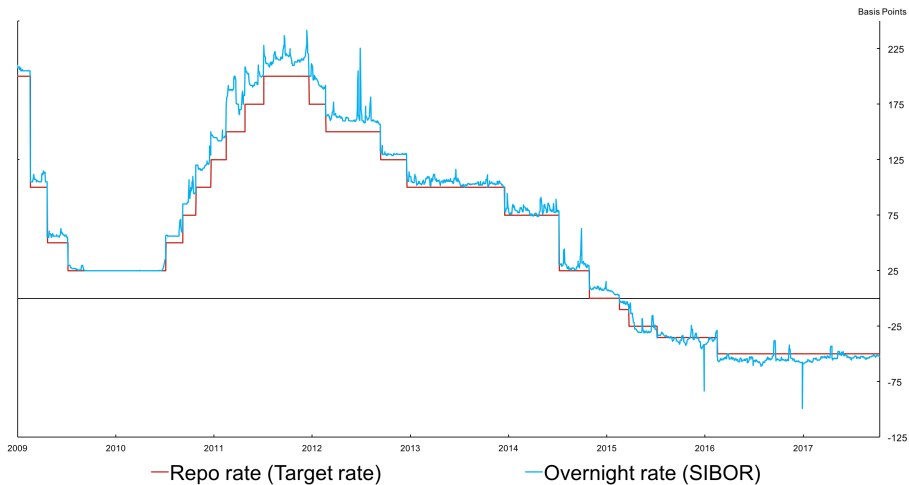
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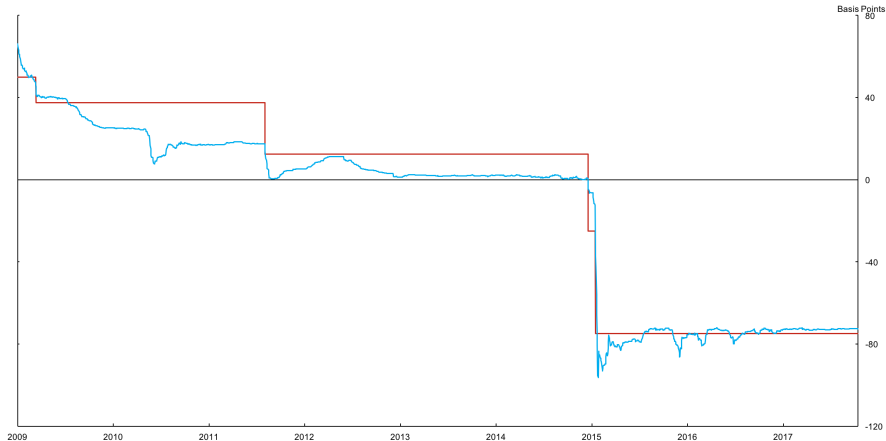
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- Crucial aspect of monetary policy is effective implementation of interest rate target.
 - Interbank lending rate = central bank target rate
- Negative rates could induce cash withdrawals and hinder effective implementation of monetary policy.
 - Optimal behaviour in light of negative deposit rate is to convert reserves to “vault cash” with zero return.
 - Return on cash is actually slightly negative, around -0.5% in Canada (Witmer and Yang, 2016).
- Negative rates have been introduced in several countries but monetary policy implementation seems to be working.

Example #1: Sweden



Example #2: Switzerland



— Midpoint of target range of three-month LIBOR rate for CHF deposits (Target rate)

— Swiss three-month LIBOR

Many unanswered questions...

- Which central bank rate matters?
 - borrowing rate? deposit rate? return on required reserves?
- Can it work with large excess reserves (ie. during QE)?
- What are the effects of tiers of policy rates? What other policy levers can we adjust to implement negative rates?

A model helps crystallize intuition around the equilibrium interbank rate. We:

- 1 Use the workhorse model of monetary policy implementation with interbank loans (Poole (1968), Bech and Keister (2013)),
- 2 add the option to exchange reserves for cash,
- 3 add tiers of policy rates,
- 4 and add varying reserve requirements.

Equilibrium Interbank Rate in Poole (1968)

Poole (1968) showed the equilibrium interbank rate depends on the:

- 1 borrowing and deposit rates
- 2 level of central bank excess reserves (MP framework)
- 3 distribution of commercial bank deposit shocks

In a corridor monetary policy framework (no excess reserves):

$$r_{interbank} \approx \frac{\text{deposit rate} + \text{borrowing rate}}{2}$$

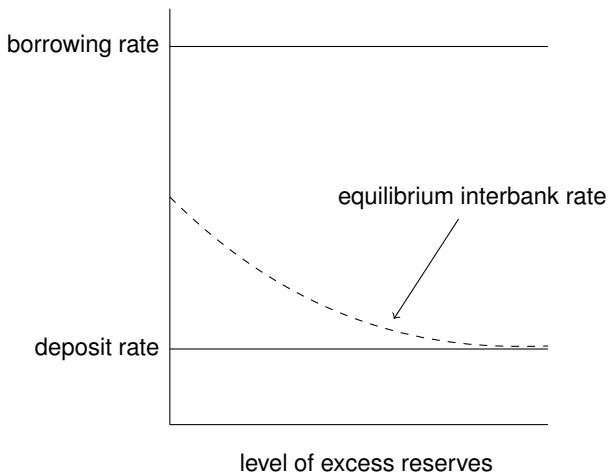
In a floor framework (high excess reserves):

$$r_{interbank} \approx \text{deposit rate}$$

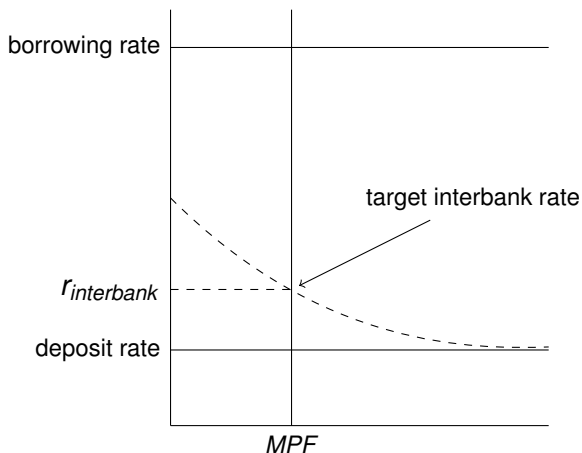
The central bank decides on r_{target} and sets policy such that:

$$r_{interbank} \approx r_{target}$$

Equilibrium Interbank Rate

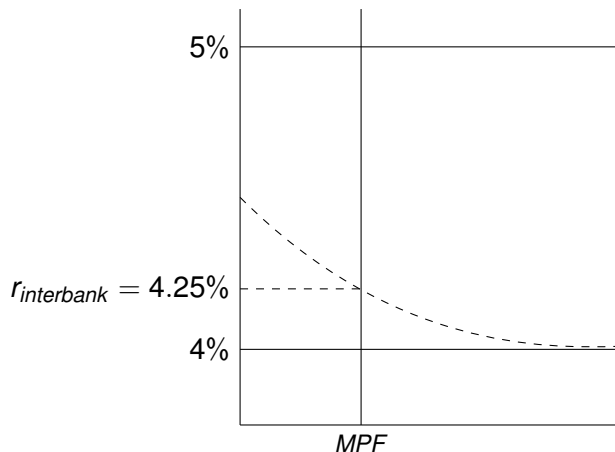


Equilibrium Interbank Rate



- $r_{interbank}$ = target interbank rate is the equilibrium outcome

Equilibrium Interbank Rate in Normal Times



- the “return on cash” is irrelevant during normal times

What we get:

- MP implementation works as expected only when:

$$r_{interbank} > r_C$$

the target/interbank rate is above the return on cash (ie. ZLB/ELB).

- Explore two alternatives to eliminate this constraint:
 - 1 tiered remuneration of reserves
 - 2 varying reserve requirements

Commercial Banks

Continuum of commercial banks that maximize expected profit. Each day is divided into five stages:

- 1 Start of Day
- 2 Interbank Borrowing and Cash/Reserve Conversion
- 3 Deposits Shock
- 4 Central Bank Borrowing (End of Day)
- 5 End of Day

Commercial Bank Balance Sheet

1 Start of Day

Assets	Liabilities
C^i Vault Cash	D^i Deposits
R^i Reserves	

2 Interbank Borrowing and Cash/Reserve Conversion

3 Deposits Shock

4 Central Bank Borrowing

5 End of Day

Commercial Bank Balance Sheet

- 1 Start of Day
- 2 Interbank Borrowing and Cash/Reserve Conversion

Assets	Liabilities
$C^i + T^i$ Vault Cash	D^i Deposits
$R^i + \Delta^i - T^i$ Reserves	Δ^i Interbank Borrowing

T^i is new vault cash converted from reserves.

- 3 Deposits Shock
- 4 Central Bank Borrowing
- 5 End of Day

Commercial Bank Balance Sheet

- 1 Start of Day
- 2 Interbank Borrowing and Cash/Reserve Conversion
- 3 Deposits Shock

Assets	Liabilities
$C^i + T^i$ Vault Cash	$D^i - \epsilon^i$ Deposits
$R^i + \Delta^i - T^i - \epsilon^i$ Reserves	Δ^i Interbank Borrowing

$\epsilon^i \sim G$ is a symmetric random variable with $E(\epsilon^i) = 0$.

- 4 Central Bank Borrowing (End of Day)

Commercial Bank Balance Sheet

- 1 Start of Day
- 2 Interbank Borrowing and Cash/Reserve Conversion
- 3 Deposits Shock
- 4 Central Bank Borrowing

Assets	Liabilities
$C^i + T^i$ Vault Cash	$D^i - \epsilon^i$ Deposits
$R^i + \Delta^i - T^i - \epsilon^i + X^i$ Reserves	Δ^i Interbank Borrowing
X^i Central Bank Borrowing	

- 5 End of Day

Central Bank Borrowing

Central bank sets required reserves and three interest rates:

- 1 Required reserves earn r_K

$K^i \equiv$ required reserves for commercial bank i

- 2 Excess reserves earn the deposit rate r_R

$$\epsilon_K^i \equiv \text{excess reserves for } i = \underbrace{(R^i - K^i)}_{\text{starting excess reserves}} + \underbrace{(\Delta^i - T^i)}_{\text{net change}}$$

- 3 Borrowing from the central bank costs $r_X > r_R$

Commercial Bank Decision

Commercial bank i chooses Δ^i and T^i to maximize expected profit *before* the deposit shock is realized.

Deposit shock is drawn from commercial bank's excess reserves.

1 Insufficient excess reserves: borrowing rate r_X if

$$\epsilon^i \geq \underbrace{(R^i - K^i)}_{\text{starting excess reserves}} + \underbrace{(\Delta^i - T^i)}_{\text{net change}} \equiv \epsilon_K^i$$

2 Sufficient/extra excess reserves: deposit rate r_R .

Interaction between cash conversions and interbank borrowing implies that cash conversions may affect implementation of monetary policy.

Equilibrium Interbank Rate

Monetary policy framework: all banks face an exogenous, constant reserve requirement:

$$K^i = \bar{k} \geq 0 \text{ and } K \equiv \int_i K^i = \bar{K}$$

Since all banks are identical, the equilibrium interbank rate is determined by aggregate balance sheet statistics:

$$MPF = R - K$$

$$\begin{aligned} r_{\Delta} &= G(MPF - T) \cdot r_R + (1 - G(MPF - T)) \cdot r_X \\ &= r_R + (r_X - r_R)[1 - G(MPF - T)] \end{aligned}$$

The equilibrium interbank rate r_{Δ} :

- 1 decreases** in the monetary policy framework MPF .
- 2 increases** in cash transfers T .

Monetary Policy Implementation

The equilibrium interbank rate is given by:

$$r_{\Delta} = r_R + (r_X - r_R)[1 - G(MPF - T)]$$

In our model, the Poole/target rate is defined as:

$$r_{target} = r_R + (r_X - r_R)[1 - G(MPF)]$$

Monetary policy implementation works normally when

$$r_{\Delta} = r_{target}$$

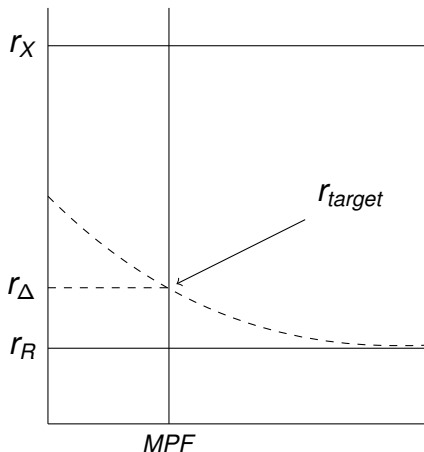
which requires that

$$T = 0$$

Monetary Policy Implementation

$$r_{target} = r_R + (r_X - r_R)[1 - G(MPF)]$$

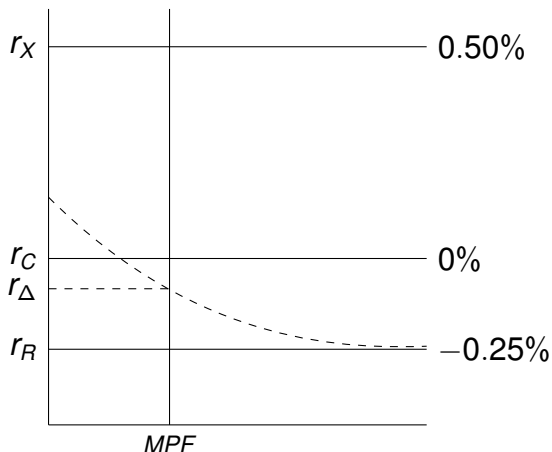
$$r_{\Delta} = r_R + (r_X - r_R)[1 - G(MPF - T)] \text{ w/ } T = 0$$



Key Question: When is $T = 0$?

Equilibrium* Interbank Rate near Zero

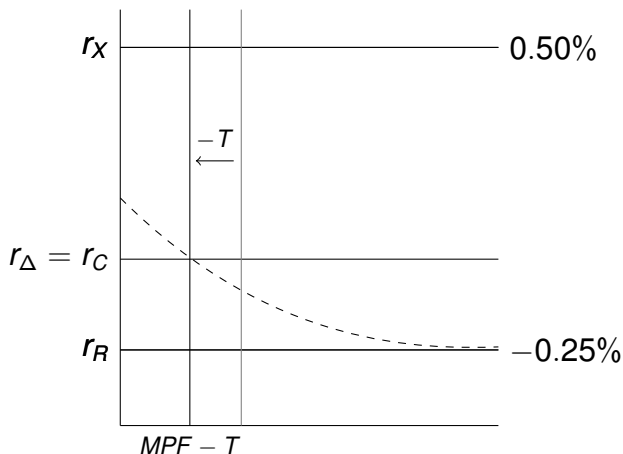
Case 1: $r_{target} < r_C$



- arbitrage: convert reserves to cash, borrow on interbank

Equilibrium Outcome

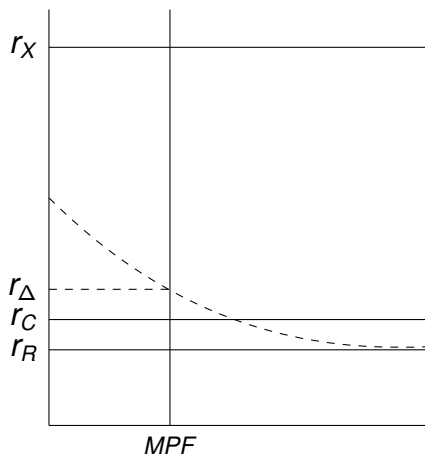
Case 1: $r_{target} < r_C$



- increasing $T > 0$ decreases r_Δ until in equilibrium $r_\Delta = r_C$

Equilibrium Interbank Rate near Zero

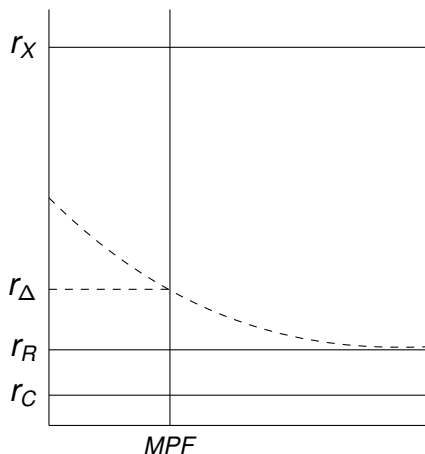
Case 2: $r_{target} > r_C$



- equilibrium outcome: $T = 0, r_\Delta = r_{target}$

Equilibrium Interbank Rate near Zero

Case 2: $r_{target} > r_C$



- equilibrium outcome: $T = 0, r_{\Delta} = r_{target}$

Summary of Equilibrium Outcomes

When $r_{target} \geq r_C$, monetary policy implementation works normally:

$$r_{interbank} = r_{target}$$

When $r_{target} < r_C$, monetary policy is constrained because

$$r_{interbank} = r_C \neq r_{target}$$

- 1 Equilibrium level of cash conversions is greater than zero.
- 2 Equilibrium interbank rate is equal to the return on cash.

Which central bank instruments matter? The deposit rate, the borrowing rate, and the monetary policy framework.

Alt. #1: Tiered Policy Rates

The central bank pays r_M on the first M reserves and r_R afterwards, with $r_R < r_M < r_X$.

The central bank target rate now depends on all three rates, the MPF, and the threshold M .

When $r_{target,M} < r_C$, an arbitrage opportunity exists in the interbank market.

Summary: When $r_{target,M} < r_C$, the interbank equilibrium rate is r_C and monetary policy implementation is constrained.

Alt. #2: Required Reserves with Varying Threshold

Each commercial bank's required reserves depends on its cash withdrawals:

$$K^i = \bar{K} - T^i$$

Central bank borrowing threshold:

$$\begin{aligned}\epsilon_K^i &\equiv (R^i - K^i) + (\Delta^i - T^i) \\ &= R^i + \Delta^i - \bar{K}\end{aligned}$$

Broken the link between cash conversions and excess reserves and, by extension, between cash conversions and interbank borrowing.

Varying Required Reserves Equilibrium Outcome

- 1 Before: cash conversion lowers reserves, need to borrow on interbank market
- 2 Now: cash conversion lowers reserve requirement, no need to borrow on interbank market

No uncertainty when choosing cash conversions T^i :

$$E[\pi^i] = \dots + r_C(C^i + T^i) + r_K(\bar{K} - T^i)$$

In equilibrium, whenever return on required reserves $r_K \geq r_C$:

- 1 The equilibrium level of cash transfers is zero.
- 2 The equilibrium interbank rate is the target rate.

Main Conclusions

- 1 The relevant rate is the target rate given the central bank rates and framework (excess reserves, threshold, etc.).
- 2 Regular and tiered monetary policy implementations are constrained when the target rate is below the return on cash.
- 3 A cash-adjusted required reserves implementation operates normally as long as the return on required reserves is above the return on cash but may present other problems.

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