On the Negatives of Negative Interest Rates and the Positives of Exemption Thresholds

Work in Progress

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Research question

- How do negative interest rates (NIR) affect
  - investment decisions of commercial banks?
  - commercial bank profitability?
  - welfare?
- How do exemptions from NIR interact with these results?

Implementation of NIR

Denmark, Euro Area, Japan, Sweden, Switzerland

- Introduction of NIR to increase inflation, economic activity or due to exchange rate considerations.
- In almost all cases, part of the reserves are exempt from NIR.
- Exemptions are due to bank profitability concerns or legal/operational issues.
- Exemptions vary across CBs.
- NIR vary across CB's from -0.1% (BOJ) to -0.75% (DN, SNB).

Table

Preview of results

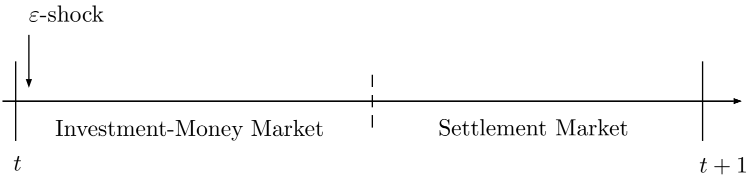
1. Perfect transmission of NIR to money market rates for any (binding) exemption.
2. Transmission of NIR to deposit rates is key for the effects on investment and welfare.
   - Investments will depend on wedge $i_d - i_n$.
3. Main message:
   - NIR distorts investment decisions.
   - Negative effects on welfare.
   - Exemptions reduce negative impact of NIR on bank profitability.

The model

The theoretical model closely follows Berentsen, Marchesiani, and Waller 2014 and Berentsen, Kraenzlin, and Müller 2018.

- Time is discrete and continues forever.
- The discount factor across periods is $\beta = (1 + r)^{-1}$.
- Unit measure of two types of infinitely lived agents: Banks and households.
- Medium of exchange: Reserves
- Two sub-periods: a settlement market and an investment-money (IM) market.

Environment

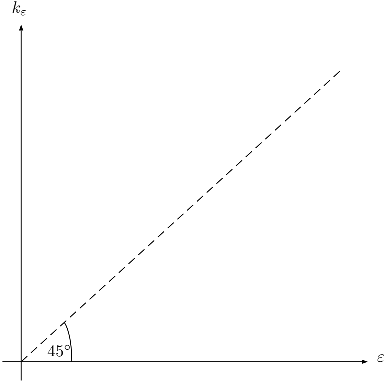


- Banks receive an i.i.d. idiosyncratic investment shock ε with distribution $G(\varepsilon)$ and support $[0, \infty]$.
- Return $f(\varepsilon, k) = \varepsilon^{1/\alpha} \frac{k^{1-1/\alpha}}{1-1/\alpha}$ from investing k units of capital.
- Households produce k at cost $c(k) = k$.

First-best allocation:

$$f'(\varepsilon, k_\varepsilon) = 1.$$

Solving for k_ε yields $k_\varepsilon^* = \varepsilon$.



Monetary policy

The central bank

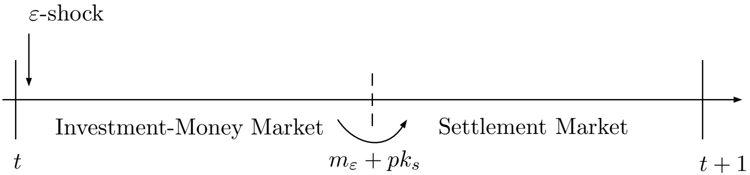
- issues reserves,
- chooses the exemption threshold $\bar{m}$,
- and chooses the interest rates i_p and i_n with $i_p \geq i_n$.

A bank with $\hat{m}_\varepsilon$ units of reserves at the end of the IM market faces the following interest rate payments:

$$\begin{aligned} i_p \hat{m}_\varepsilon, \text{ if } \hat{m}_\varepsilon \leq \bar{m} \\ i_p \bar{m} + i_n(\hat{m}_\varepsilon - \bar{m}), \text{ if } \hat{m}_\varepsilon \geq \bar{m}. \end{aligned} \tag{1}$$

IM market

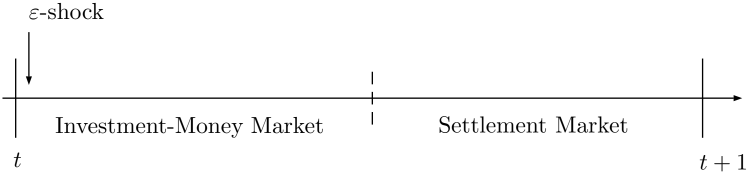
Investment decision



- Banks purchase capital from households at price p.
- Households deposit their earnings at accounts held with banks at interest rate i_d.
- Each household produces the same amount and each bank has the same customer base.

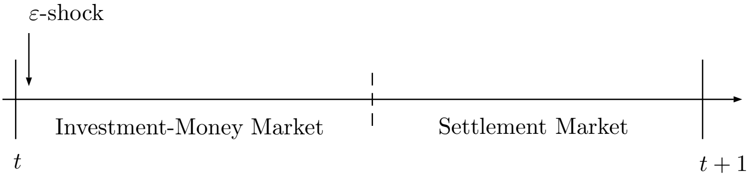
IM market

Money market decision



- Banks with high high ε-shocks can borrow money from banks with low ε-shocks:
  - Borrow to spend on capital or to deposit at the central bank at interest rate i_p.
- Banks need collateral to borrow in the money market.
  - A fraction θ of reserve inflow at the end of the IM.
  - A fraction σ of reserves held at the central bank.

Settlement market



- Agents repay their loans/deposits and readjust their portfolio.
- Agents receive utility x from consuming x units of the consumption good.
- Agents can work h hours at disutility h.
- Price of consumption good $P^x = 1/\phi$.

Result: Perfect transmission to i_m

Perfect transmission to money market rate

Full pass through of the policy rate i_n to the money market rate i_m if $\bar{m} < m$ and i_n is not too low.

Implication

- The central bank is able to perfectly control the money market rate without affecting bank profitability by setting $\bar{m} \to m$.
- The interest rate i_p does not affect investment decisions.

Result: Investment

The quantities invested satisfy

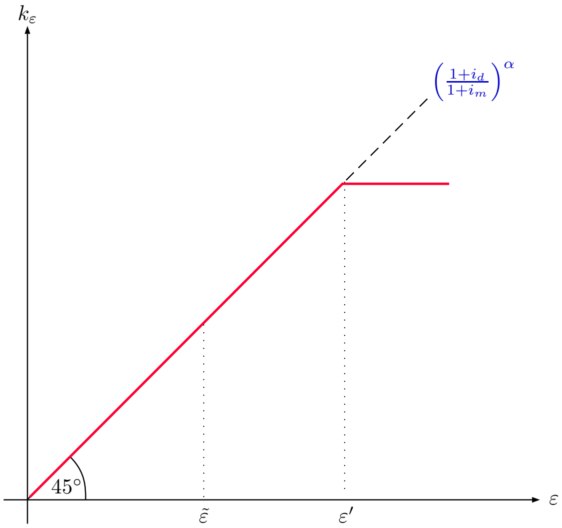
$$
\begin{aligned}
k_\varepsilon &= \varepsilon\,(\rho_n/\rho_d)^\alpha\,, \quad \textit{if}\ 0 \le \varepsilon \le \varepsilon' \\
k_\varepsilon &= \varepsilon'(\rho_n/\rho_d)^\alpha \quad\ \ \textit{if}\ \varepsilon \ge \varepsilon'.
\end{aligned} \tag{2}
$$

Maximization problems

Result: Wedge $i_d - i_n$ is key

- Wedge
$$i_d - i_n$$
is key for the effects of NIR on investment and welfare.
- We use the following labels:
  - Perfect transmission: $i_d = i_n$.
  - Imperfect transmission: $i_d > i_n$ (NIR countries).
  - Imperfect transmission: $i_d < i_n$ (US Case).

Perfect transmission: $i_n = i_d$



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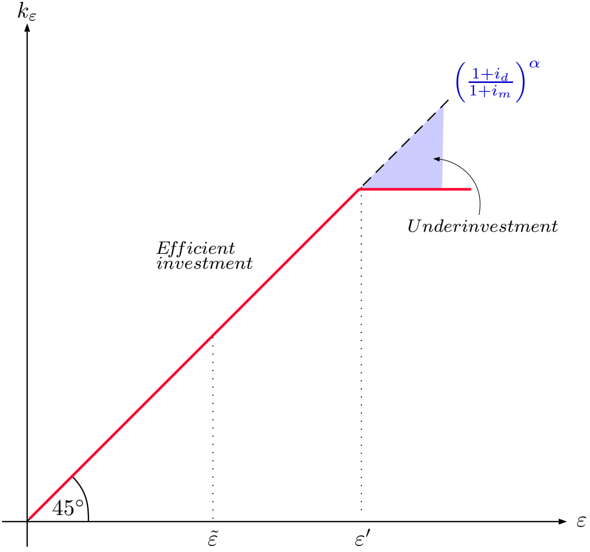
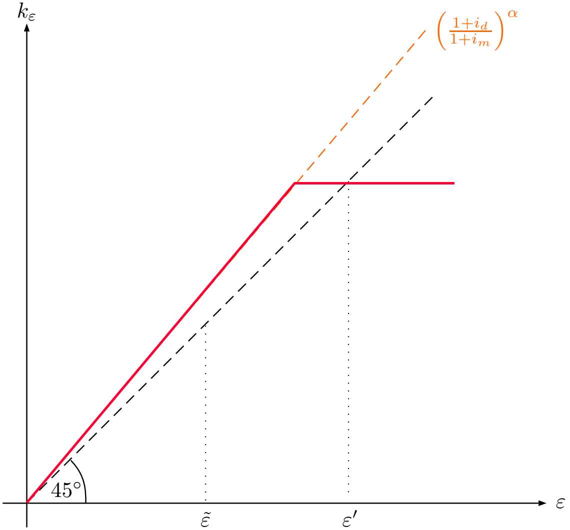


Imperfect transmission: $i_n < i_d$ (NIR)



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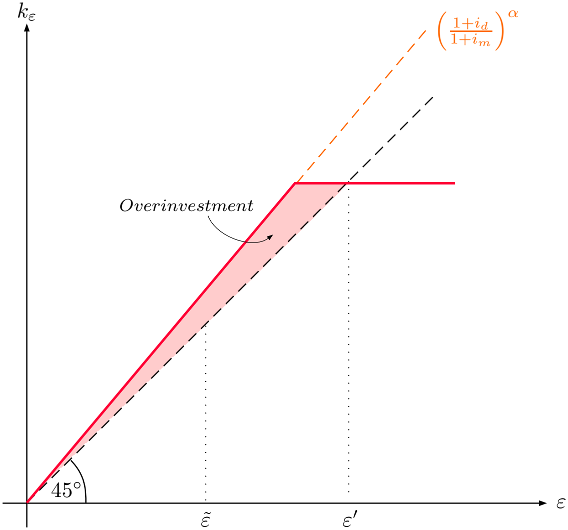

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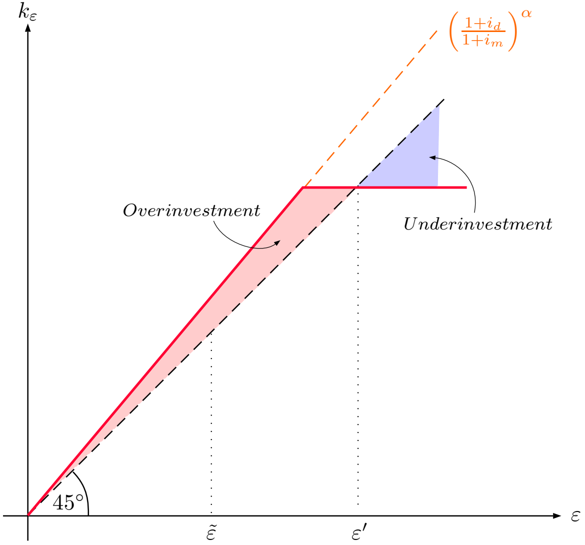


Imperfect transmission: $i_n < i_d$ (NIR)

- Several observations of limited transmission to deposit rates during NIR periods:
  - See Dell'Ariccia et al. 2017; Basten and Mariathasan 2018; Heider, Saidi, and Schepens forthcoming or Eisenschmidt and Smets 2017.
- Observations of high investment for instance in real estate in Switzerland:
  - Both the SNB and the FINMA have stated that there are tendencies to overheat in the Swiss real estate market (10. FINMA Jahreskonferenz, April 2019, SNB Monetary Policy Assessment, June 2019).

Welfare effects of lowering i_n

Welfare satisfies

$$(1-\beta)\mathcal{W} = \int_0^\infty \left[\varepsilon^{(1/\alpha)} f(k_\varepsilon) - k_\varepsilon\right] dG. \tag{3}$$

$$\frac{d(1-\beta)\mathcal{W}}{d\rho_n} = A + B + C$$

$$\text{where } A \equiv \rho_d \int_0^{\varepsilon'} [i_n - i_d] \frac{dk_\varepsilon}{d\rho_n} dG,$$

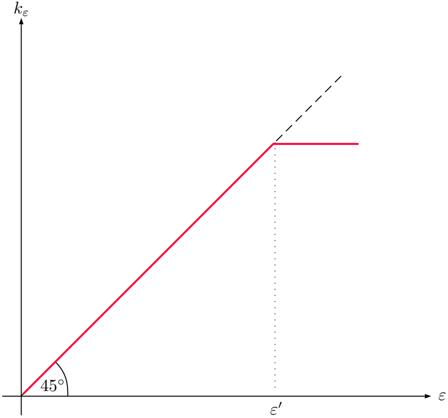
$$B \equiv \int_{\varepsilon'}^{\hat{\varepsilon}} [(\varepsilon/\hat{\varepsilon})^{1/\alpha} - 1] \frac{d\hat{\varepsilon}}{d\rho_n} dG,$$

$$C \equiv \int_{\hat{\varepsilon}}^{\infty} [(\varepsilon/\hat{\varepsilon})^{1/\alpha} - 1] \frac{d\hat{\varepsilon}}{d\rho_n} dG.$$

Perfect transmission US Case

Imperfect transmission: IC $i_n = i_d$

$$\frac{d(1-\beta)\mathcal{W}}{d\rho_n} = A + B + C$$



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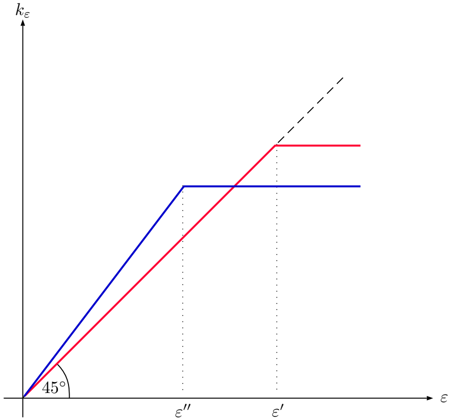

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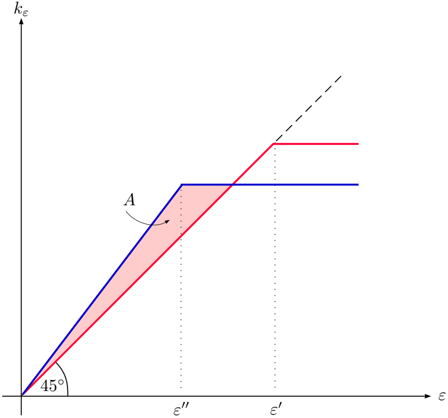

Imperfect transmission: IC $i_n = i_d$

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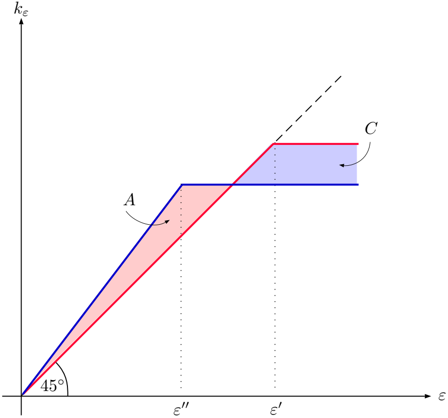

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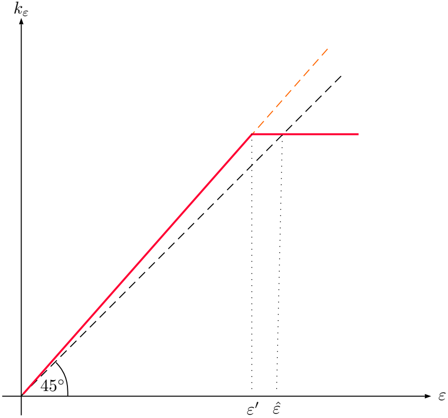

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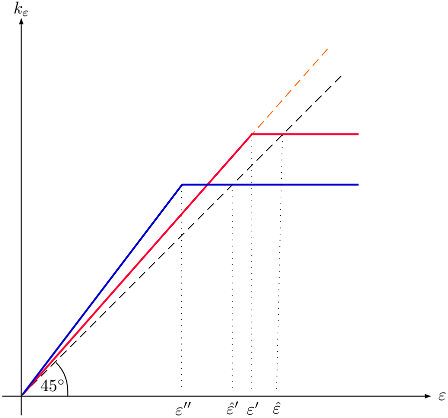

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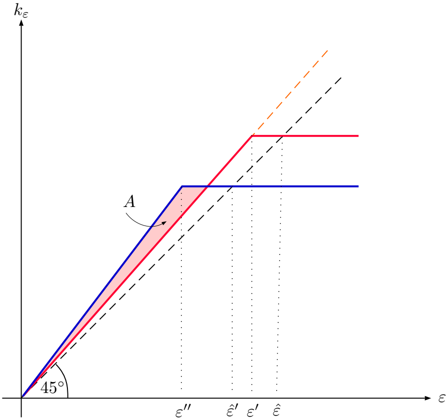

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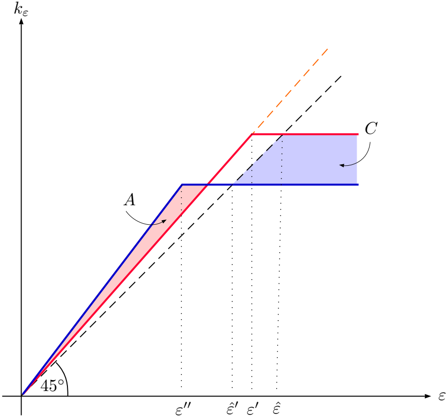

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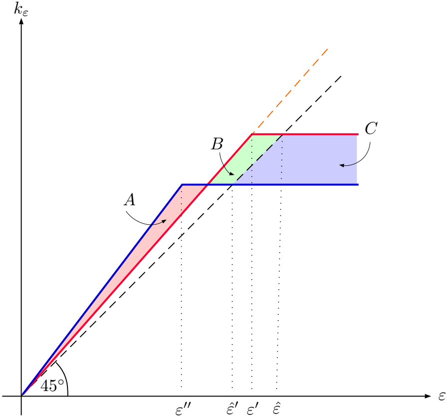

Welfare effects

Negative welfare effects

A decrease in i_n unambiguously lowers welfare in all cases.

Conclusion

1. Perfect transmission of NIR to money market rates for any (binding) exemption.

2. Transmission of NIR to deposit rates is key for the effects on investment and welfare.
   - Investments depend on wedge $i_d - i_n$.

3. Main message:
   - NIR distorts investment decisions.
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Thank you for your attention

References I

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Implementation of NIR

As of 13 September 2019	Exemptions	Interest rates	Degree of transmission	Objective of NIR
Bank of Japan	Yes	0.1%, 0%, -0.1%	Partial transmission	Inflation and economic activity
Danmarks Nationalbank	Yes	0%, -0.65%	Partial transmission	Exchange rate considerations
European Central Bank	Yes	0%, -0.5%	Partial transmission	Inflation
Swedish Riksbank	No	0%, -0.1%	Partial transmission	Inflation
Swiss National Bank	Yes	0%, -0.75%	Partial transmission	Exchange rate considerations

Table: Implementation of NIR across CB

Back to Summary

The value function of a household at the beginning of the settlement market is

$$W_S(\hat{d}) = \max_{d \geq 0} \{-\gamma d + \beta W_{IM}(d)\} + \hat{d}/\rho_d + \tau_H.$$

FOC:

$$-\gamma + \beta W_{IM}^{d}(d) \geq 0, \quad \text{with equality if } d > 0.$$

The value function of a bank at the beginning of the settlement market is

$$V_S(\hat{m}, \hat{z}, \hat{d}) = \max_{m \geq 0} \left\{ \gamma(m - d) + \beta \int_0^\infty V_{IM}(m, d|\varepsilon) \mathrm{d}G \right\}$$
$$- \hat{d}/\rho_d - \hat{z}/\rho_m + \min\{\hat{m}, \bar{m}\}/\rho_p + \max\{\hat{m} - \bar{m}, 0\}/\rho_n + \tau_B.$$

FOC:

$$0 \leq -\gamma + \beta \int_0^\infty V_{IM}^m(m, d|\varepsilon) \mathrm{d}G, \quad \text{with equality if } m > 0.$$

The value function of a household at the beginning of the IM market is

$$W_{IM}(d) = \max_{k_s \geq 0} \{-k_s + [pk_s + d]/\rho_d\} + W_S(0).$$

FOC:

$$p = \rho_d.$$

The value function of a bank at the beginning of the IM market is

$$V_{IM}(m, d|\varepsilon) = \max_{k_\varepsilon, m_\varepsilon} \left\{ \begin{array}{l} \varepsilon^{1/\alpha} \dfrac{k_\varepsilon^{1-1/\alpha}}{1-1/\alpha} + V_S(0) - \dfrac{d + pk_s}{\rho_d} \\ - \dfrac{m_\varepsilon + pk_\varepsilon - m}{\rho_m} + \dfrac{\min\{m_\varepsilon + pk_s, \bar{m}\}}{\rho_p} \\ + \dfrac{\max\{m_\varepsilon + pk_s - \bar{m}, 0\}}{\rho_n} \end{array} \right\},$$

$$\begin{aligned} \text{s.t.} \quad & pk_\varepsilon + m_\varepsilon(1-\sigma) - m \leq \theta pk_s, \\ & m_\varepsilon \geq 0. \end{aligned}$$

The first-order conditions are:

$$
\begin{aligned}
k_\varepsilon: \quad & 0 = (\varepsilon/k_\varepsilon)^{1/\alpha} - p(1/\rho_m + \lambda_\varepsilon) && (4)\\
m_\varepsilon: \quad & 0 \geq -1/\rho_m + \mathcal{I}_+/\rho_n + (1-\mathcal{I}_+)/\rho_p - (1-\sigma)\lambda_\varepsilon + \mu_\varepsilon && (5)\\
& 0 \leq -1/\rho_m + \mathcal{I}_-/\rho_n + (1-\mathcal{I}_-)/\rho_p - (1-\sigma)\lambda_\varepsilon + \mu_\varepsilon && (6)
\end{aligned}
$$

Money market

The amount of reserves carried out of the IM market, m_ε satisfies

$$m_\varepsilon \leq \begin{cases} \bar{m}' & \text{if } i_n < i_m \leq i_p \\ 0 & \text{if } i_m > i_p \geq i_n \end{cases} \quad \text{and} \quad m_\varepsilon \geq \begin{cases} \bar{m}' & \text{if } i_n \leq i_m < i_p \\ 0 & \text{if } i_m \geq i_p \geq i_n \end{cases}.$$

Equilibrium

We focus on symmetric stationary equilibria with strictly positive demand for reserves and a positive initial stock of reserves, M_0. Market clearing requires

$$k_s = \int_0^\infty k_\varepsilon dG(\varepsilon). \tag{7}$$

and

$$m = \int_0^\infty m_\varepsilon dG(\varepsilon) + pk_s. \tag{8}$$

Equilibrium

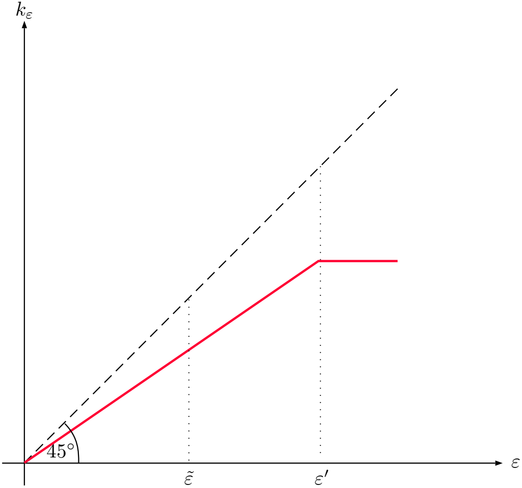
A symmetric stationary equilibrium with a positive demand for reserves is a policy $(\bar{m}, \rho_n, \rho_p)$ *and endogenous variables* (ε', ρ_m) *satisfying Equations (8) and*

$$\frac{\gamma \rho_n}{\beta} = \int_0^{\varepsilon'} \mathrm{d}G + \int_{\varepsilon'}^{\infty} \left(\varepsilon/\varepsilon'\right)^{1/\alpha} \mathrm{d}G. \tag{9}$$

with $\rho_m = \rho_n$.

Back to Result: Investment

Imperfect transmission: $i_n > i_d$ (US)



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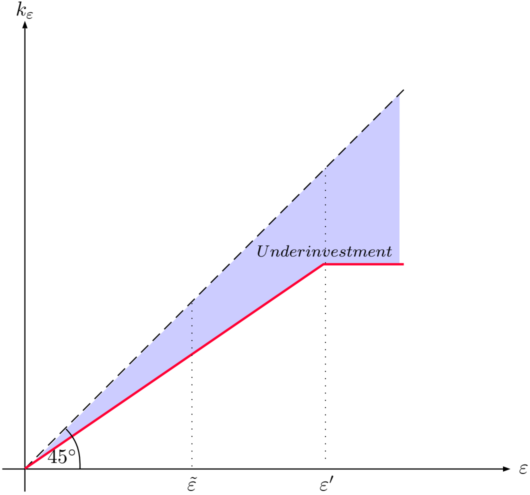

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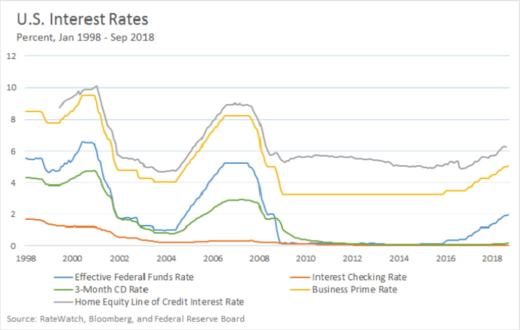
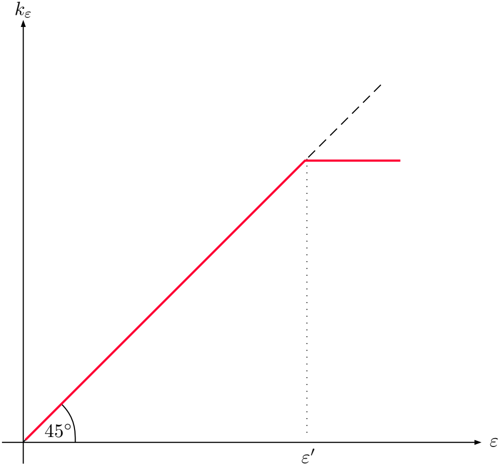


Figure: U.S Interest Rates (Andolfatto (2018))

Back to Overview

Perfect transmission

$$\frac{d(1-\beta)\mathcal{W}}{d\rho_n} = A + B + C$$



Perfect transmission

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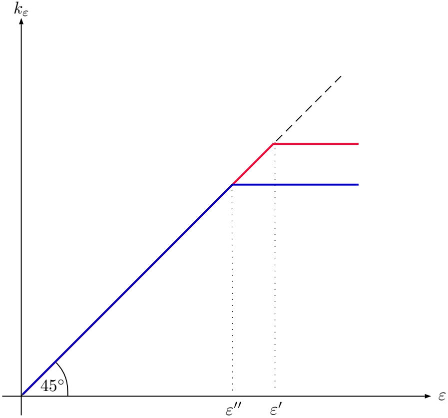
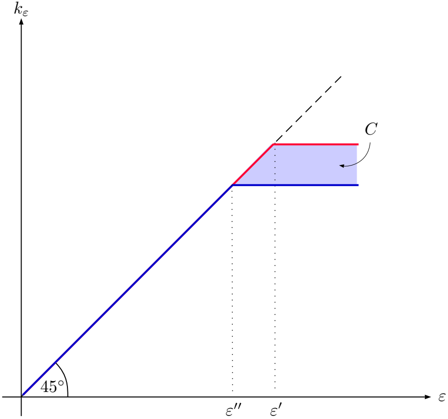


Perfect transmission

$$\frac{d(1-\beta)\mathcal{W}}{d\rho_n} = A + B + C = C < 0$$



Back to Welfare effects

Imperfect transmission: $i_n > i_d$ (US)

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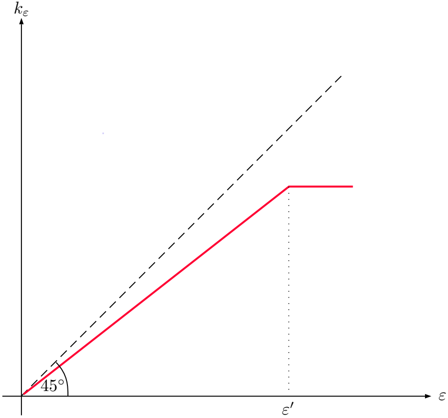

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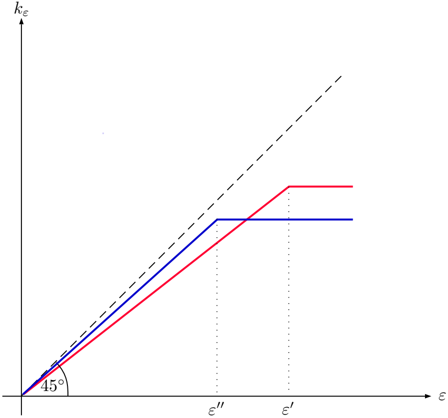

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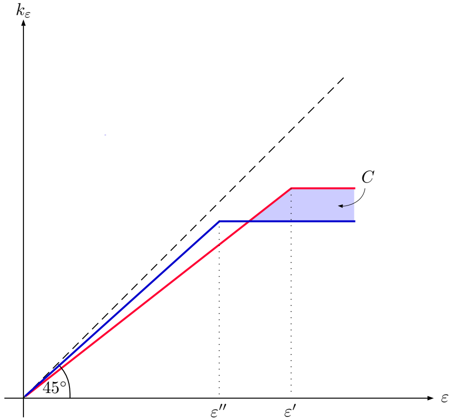

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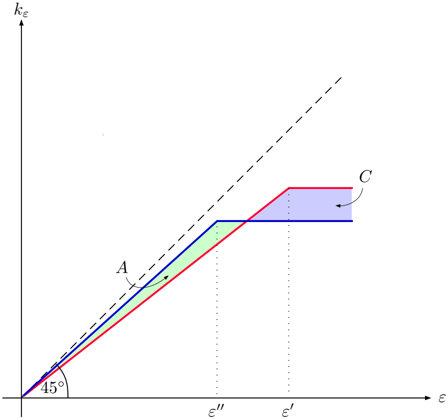

Back to Welfare effects