Are Negative Nominal Interest Rates Expansionary?

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September 2017

Motivation

- Interest rates have been declining for past three decades
  - Reached levels close to zero in response to the financial crisis
- Are nominal interest rates bounded by zero?
  - Interest rates and storage costs of money
- Negative central bank rates in a handful of economies
  - Denmark, Euro Area, Japan, Sweden, Switzerland
- Negative central bank rates clearly feasible - but are they expansionary?
  - Key monetary policy question in planning for the next recession

Nothing special?

- Bank of England (2013): “This is exactly the mechanism that operates when Bank Rate is reduced in normal times; there is nothing special about going into negative territory.”

- The Riksbank (2015): “Cutting the repo rate below zero, at least if the cuts are in total not very large, is expected to have similar effects to repo-rate cuts when the repo rate is positive, as all channels in the transmission mechanism can be expected to be active.”

- Swiss National Bank (2016): “As this status report will show, the laws of economics do not change significantly when interest rates turn negative.”

This paper

- Use aggregate and bank level data to document that
  - Deposit rates are bounded by zero
  - … causes lending rates to be bounded as well
- Implication: need a model with multiple interest rates
- New Keynesian model (Benigno, Eggertsson and Romei 2014) with bank reserved added as in Curdia and Woodford (2011)
  - Lending rate, deposit rate and central bank reserve rate
- Negative CB rates are not expansionary when deposit rate is bounded
  - Limited impact on interest rates faced by households
  - Negative impact on bank profits
  - Potential feedback from bank profits to aggregate demand through credit supply – negative CB rates become contractionary

- Literature
- Aggregate data
- Bank level data
- Model
- Results
- Summary

Literature

- Descriptive studies of negative rate pass-through
  - Jackson (2015), Bech and Malkhozov (2016)
- ZLB Literature
  - Krugman (1998), Eggertsson and Woodford (2006)
  - Curdia and Woodford (2011), Benigno, Eggertsson and Romei (2014)
- Negative interest rates
  - Rognlie (2015): negative interest rates are expansionary, but entails inefficient subsidy to money (only one interest rate)
  - Brunnermeier and Koby (2016): reversal rate (potentially negative)
  - Heider, Saidi and Schepens (2017): lower pass-through for Euro Area banks with high deposit shares post-zero

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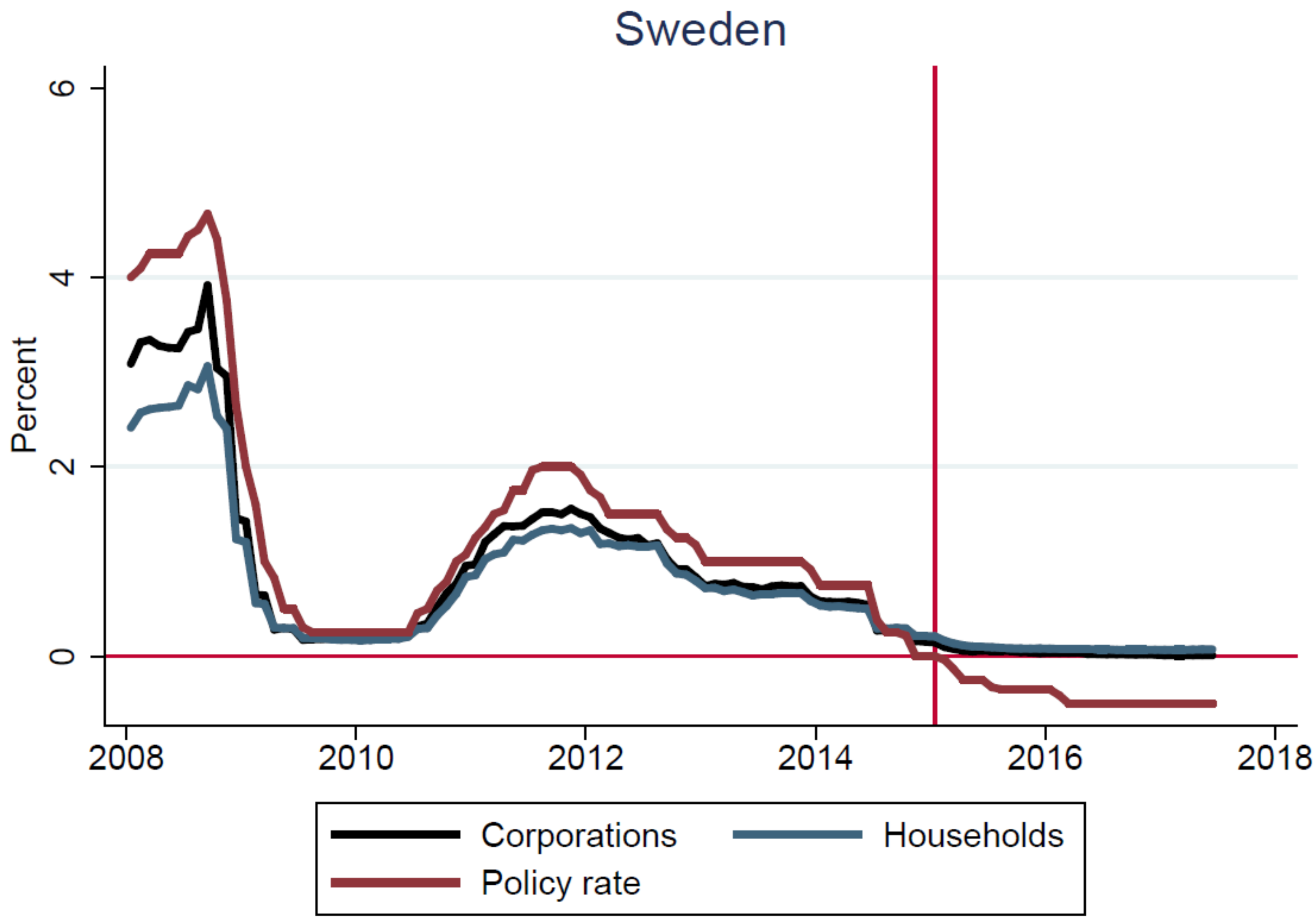
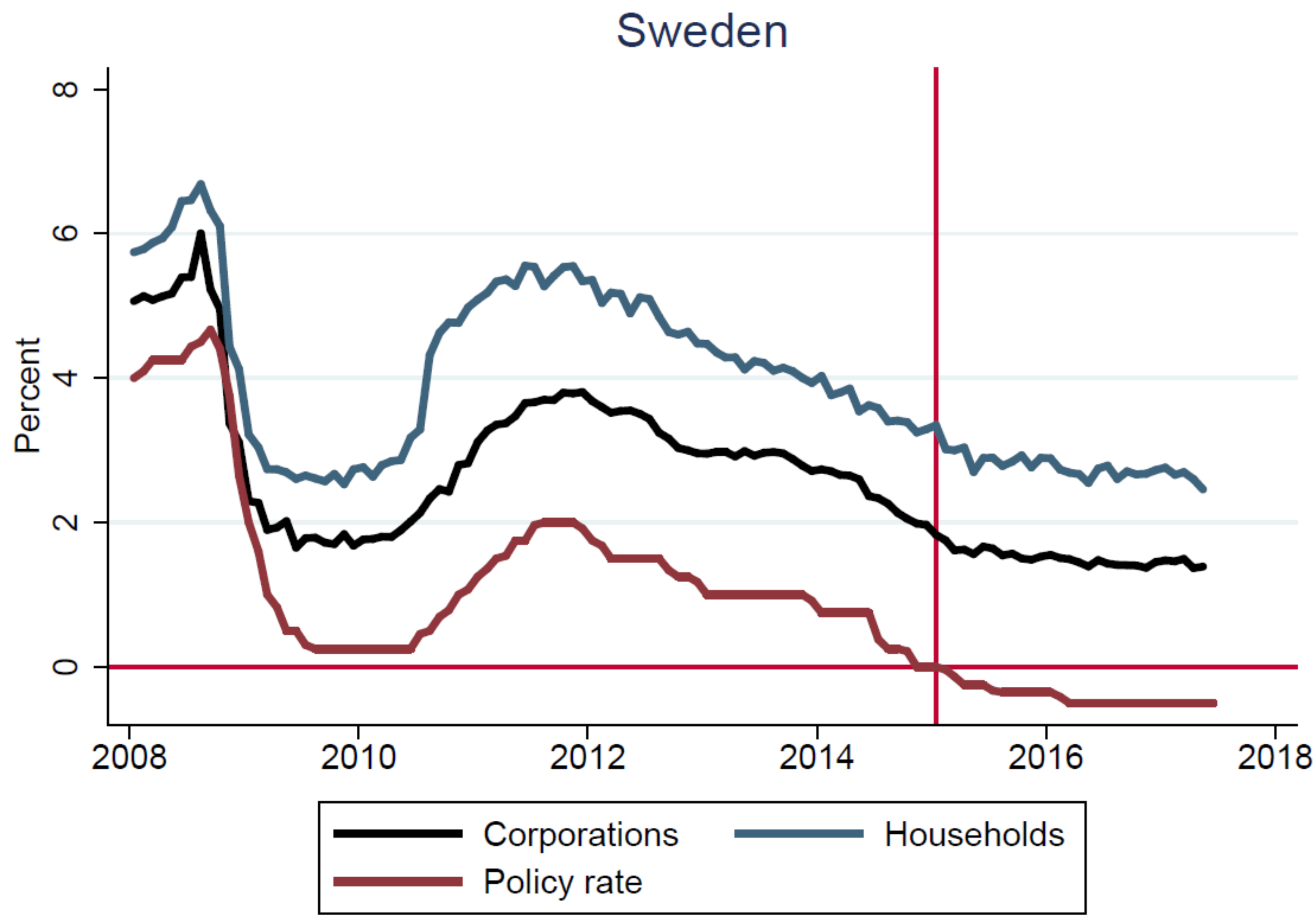
Deposit rates are bounded



[Other countries]

Lending rates appear bounded too



[Other countries](#)

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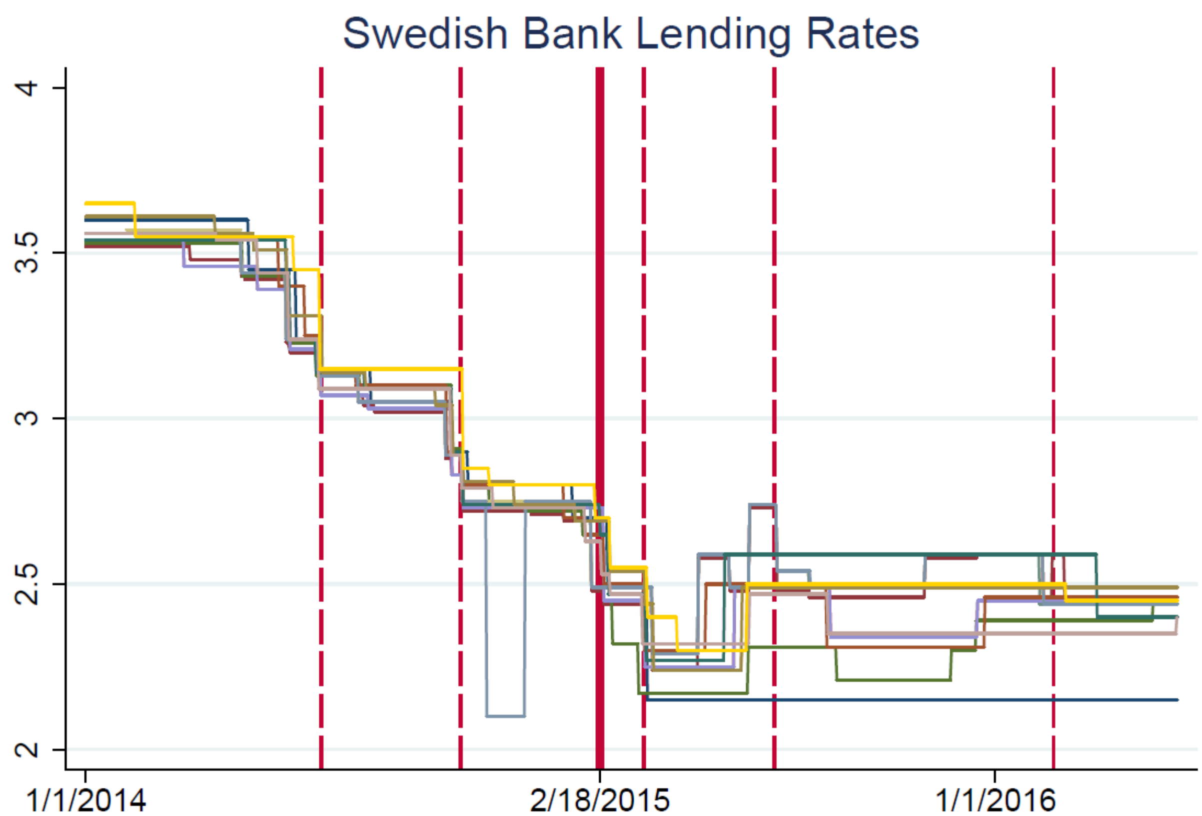
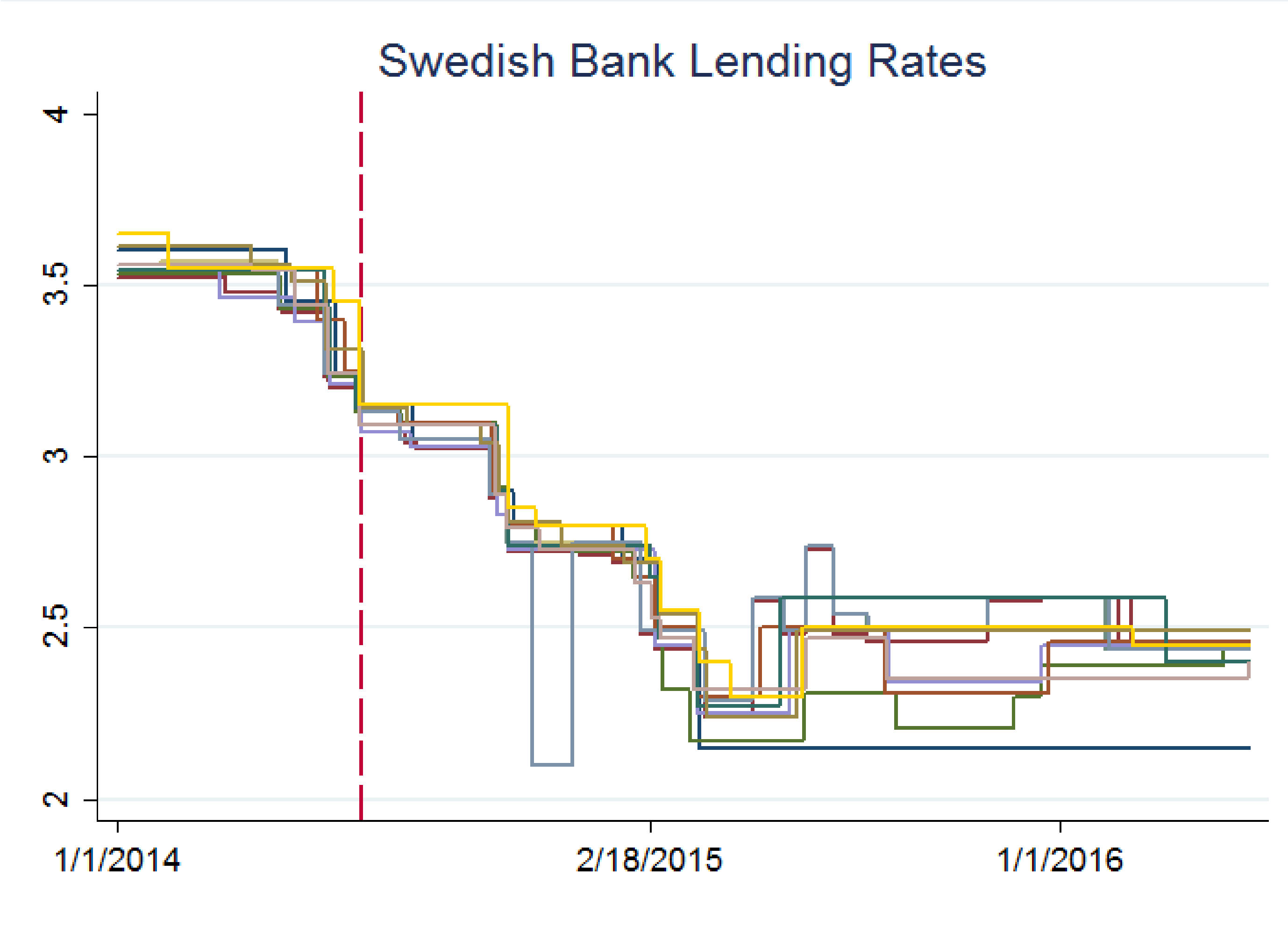
Bank level interest rates

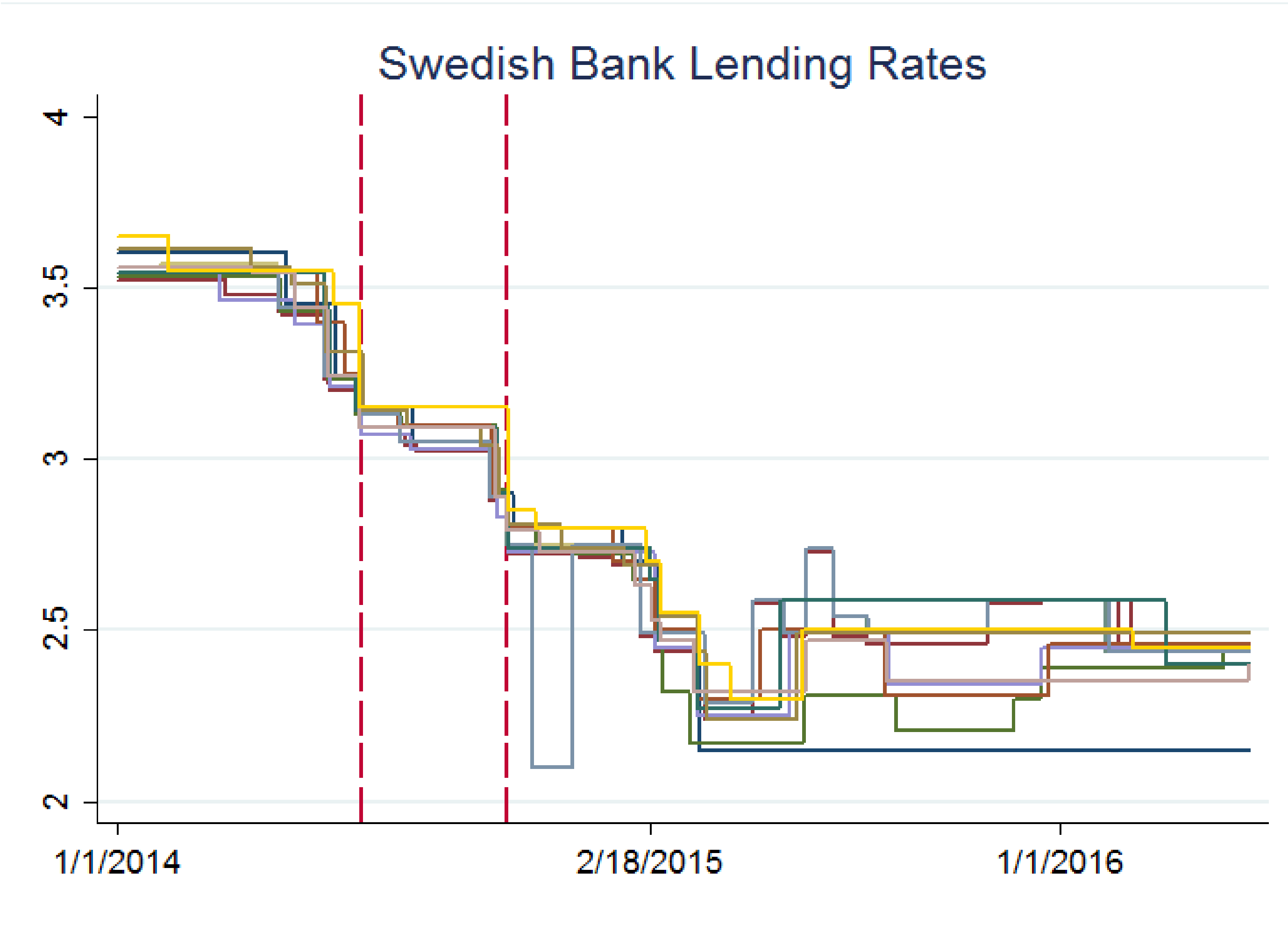
- Policy rate cuts above zero reduce bank lending rates – policy rate cuts below zero do not
- Higher dispersion in bank lending rates once the policy rate is negative



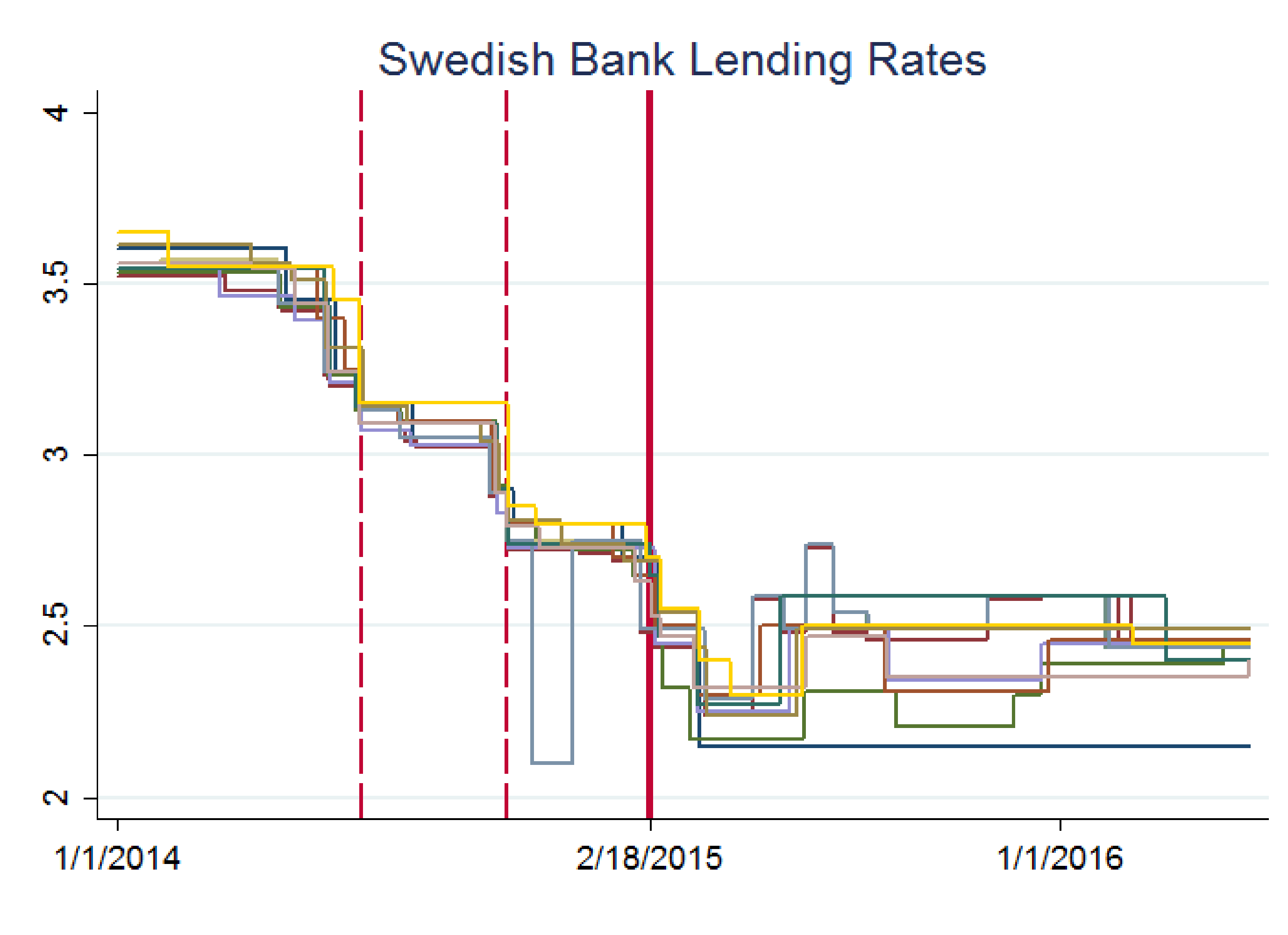
Bank Level Interest Rates



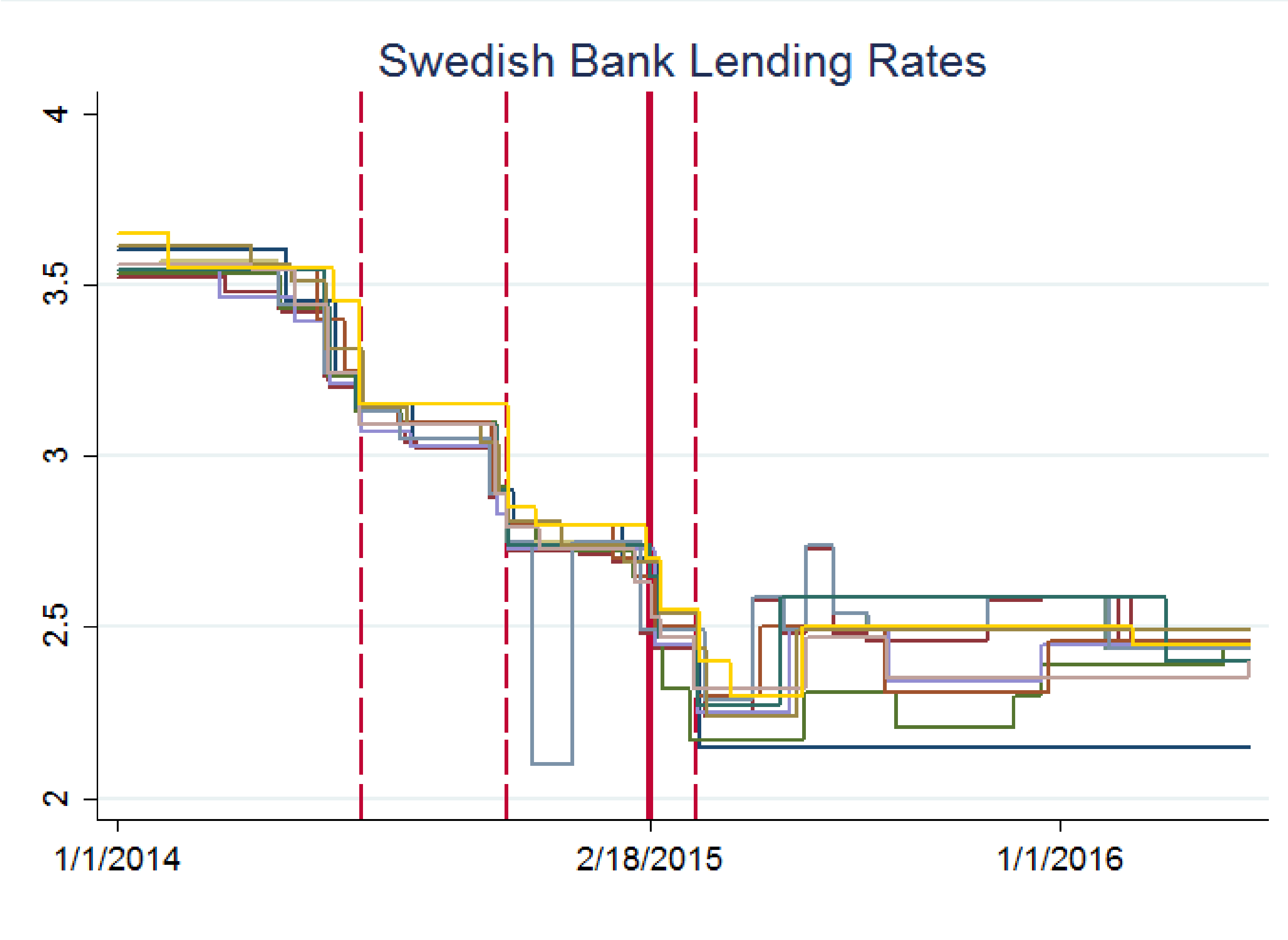
Bank Level Interest Rates



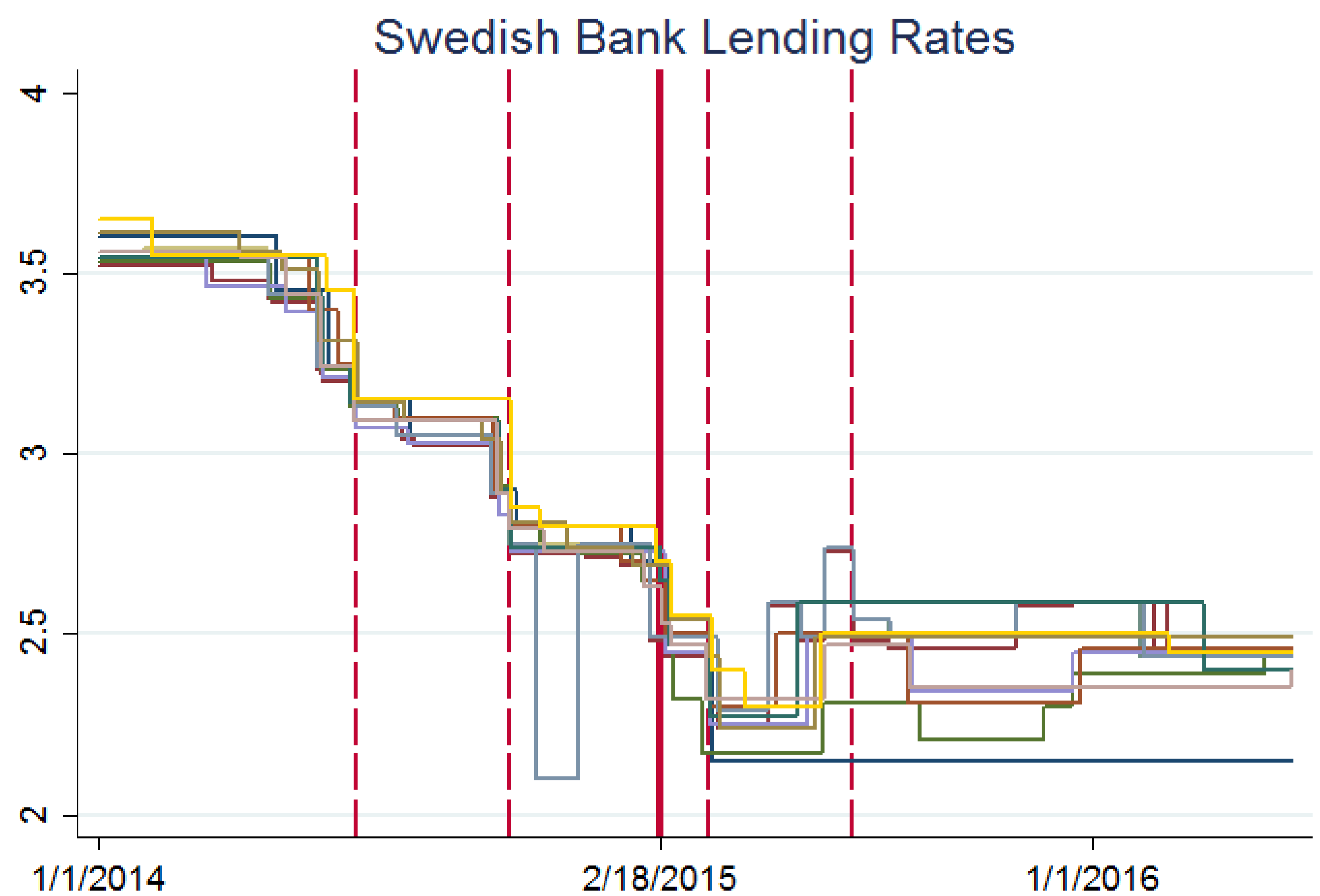
Bank Level Interest Rates



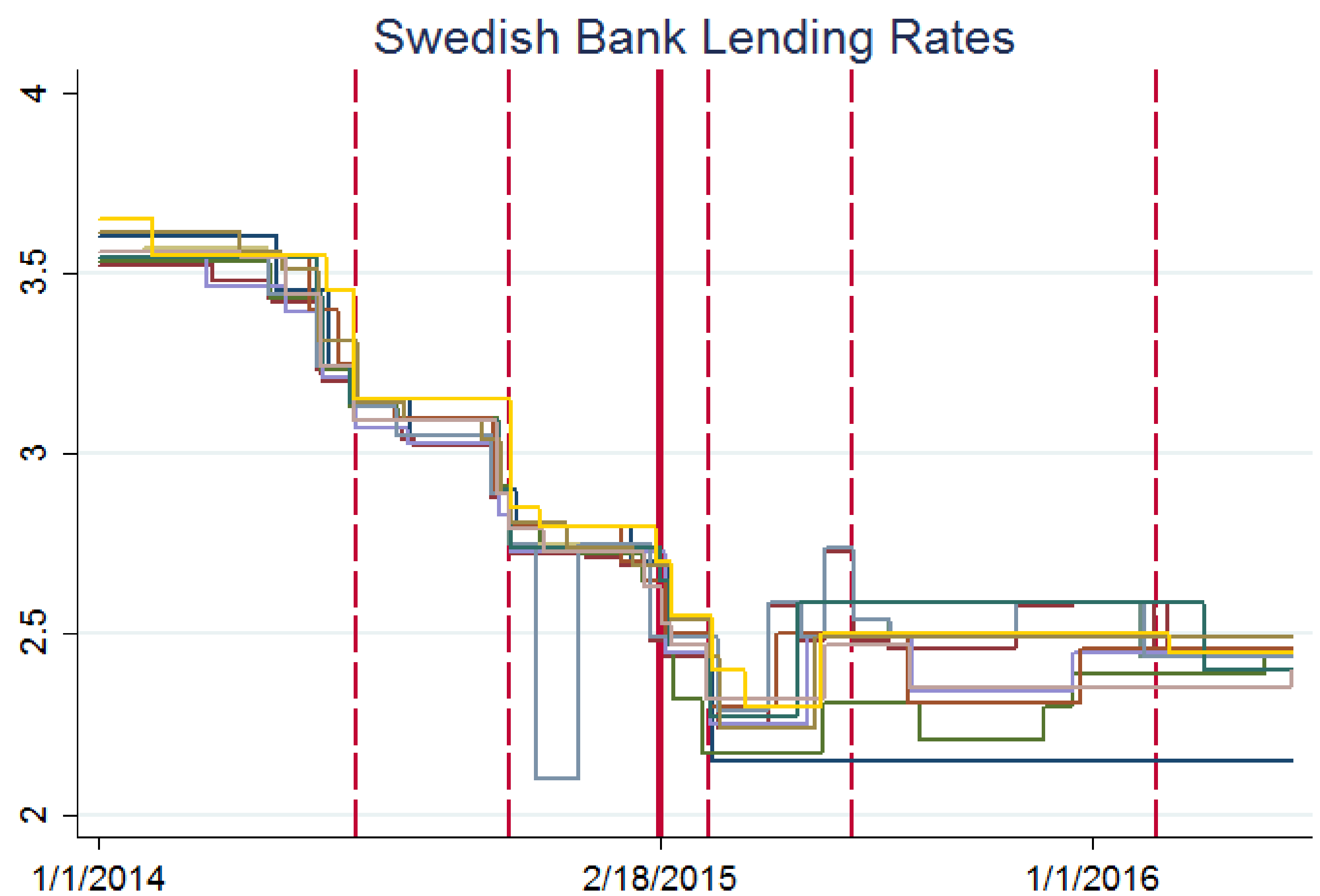
Bank Level Interest Rates



Bank Level Interest Rates

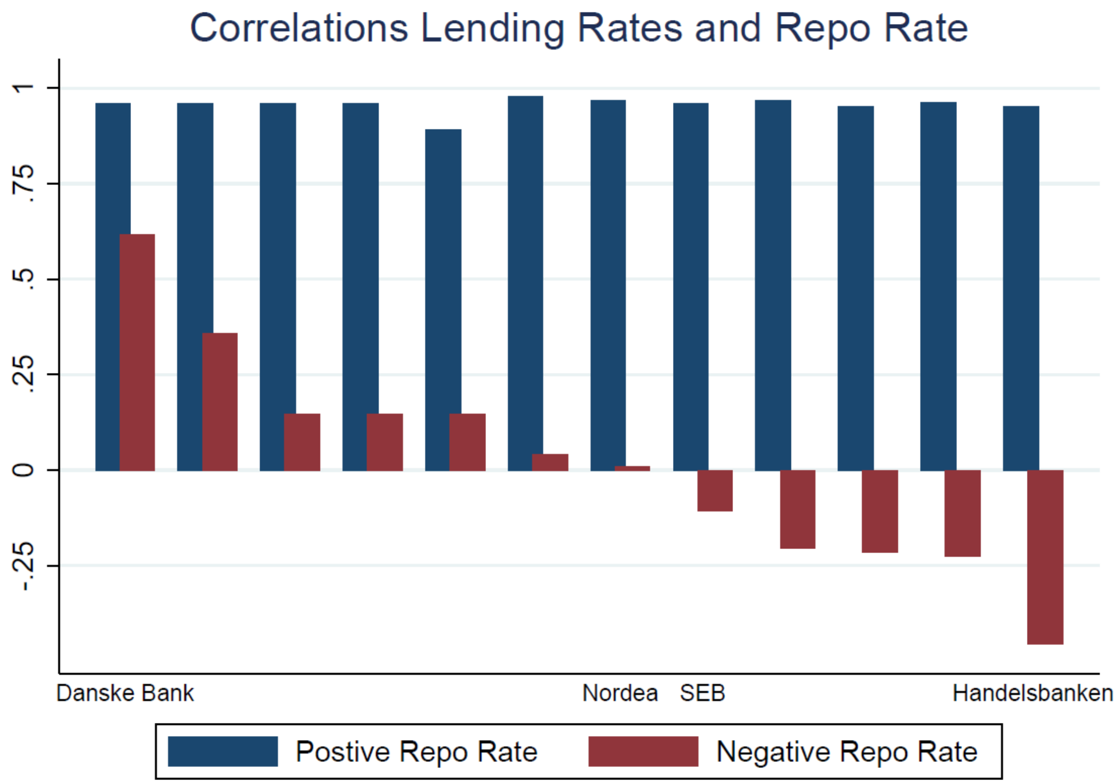


Bank Level Interest Rates



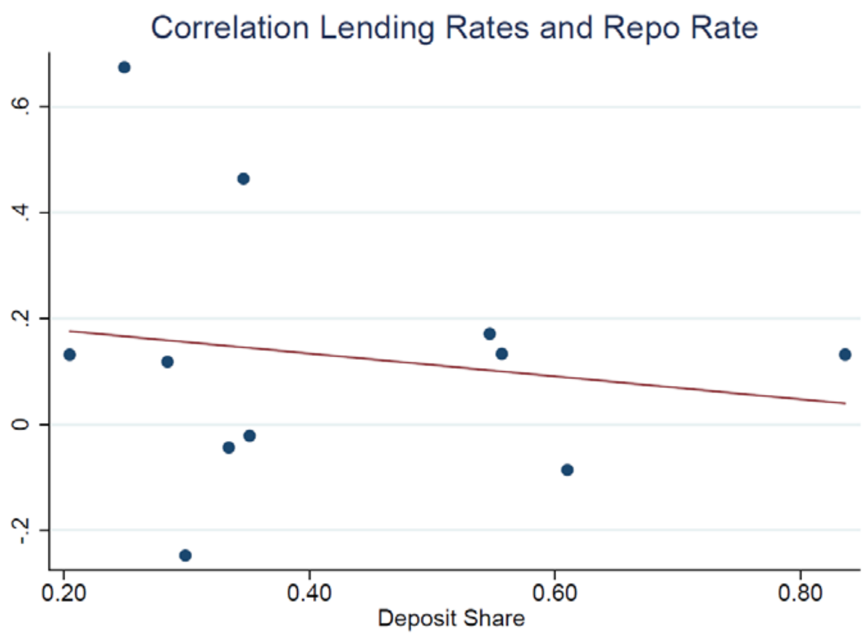
Collapse in pass-through

- Average correlation when policy rate is positive is 0.96 percent
- Average correlation when policy rate is negative is 0.02 percent



Deposit share matters

- Banks with high deposit shares have low pass-through
- Heider et al (2017): Euro area banks with high deposit shares have lower growth in lending volumes post-zero
- Show that the same holds for Swedish banks (regression)
- Suggests that the bound on deposit rates is affecting the pass-through to lending rates



Empirical findings

- Deposit rates are bounded at some level close to zero
- The pass-through to lending rates collapses once the policy rate is negative
- Lower pass-through for banks with high deposit shares suggests that the bound on deposit rates is affecting the pass-through to lending rates
- Build a model to match these empirical facts
- Need a model with multiple interest rates to capture decline in pass-through

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Analytical lower bound

- Money provides utility $\Omega(M)$, but there exists a satiation point $\bar{m}$
  - $\Omega'(M) = 0$ for $M \geq \bar{m}$, $\Omega'(M) = 0$ otherwise
- Storage cost of holding money $S(M)$
- Opportunity cost of holding money is the interest rate i
- Equilibrium condition: $\frac{\Omega'(M)}{U'(C)} - S'(M) = i$
- Lower bound $\underline{i}$ given by the lowest interest rate which satisfies this condition
- No storage costs: if $S(M) = 0$, then $\underline{i} = 0$
- Proportional storage costs: if $S(M) = \gamma M$, then $\underline{i} = -\gamma$

Households

- Two types of households, patient and impatient.
- Households maximize utility (1) subject to budget constraint (2)

1. $U_t^j = E_t \sum_{T=t} \left(\beta^j\right)^{T-t} \xi_T \; u\left(C_T^j, M_T^j, N_T^j\right)$
2. $P_t C_t^j + B_{t-1}^j \left(1 + i_{t-1}^j\right) = B_t^j + W_t^j N_t^j + \Psi_t^j + \psi_t^j$

- ξ_t is a preference shock
- Ψ_t is firm profit and ψ_t is bank profit

First-order conditions

Firms

- Firm sector identical to Benigno, Eggertsson and Romei (2014)
- Continuum of firms
- Nominal rigidities – Calvo pricing
- Aggregate supply relation:
  - $\widehat{\Pi}_t = \kappa \widehat{Y}_t + \beta \, \mathrm{E}_t \, \widehat{\Pi}_{t+1}$

Bank sector

- Assets: loans L_t with interest rate i_t^b, reserves R_t with interest rate i_t^r and money M_t^b

- Liabilities: deposits D_t with interest rate i_t^s

- Intermediation cost $\Gamma\left(\frac{L_t}{\bar{L}_t}, R_t, M_t^b, \pi_t\right)$
  - $\Gamma_L > 0$ and $\Gamma_{LL} \geq 0$
  - $\Gamma_R \leq 0$ and $\Gamma_R = 0$ for $R \geq \bar{R}$
  - $\Gamma_M \leq 0$ and $\Gamma_M = 0$ for $M^b \geq \bar{M}^b$
  - $\Gamma_\pi < 0$

Banks net worth and credit supply

- Concern that negative interest rates are reducing bank profits

- Why do we care about bank profits?
  - Lower bank profits may reduce credit supply

- Established literature linking banks net worth to their financing costs due to agency costs
  - Holmstrom and Tirole (1997), Gertler and Kiyotaki (2010), Jiménez and Ongena (2012)

- Reduced form capture: intermediation cost depends negatively on profits, $\Gamma_\pi < 0$
  - If instead $\Gamma_\pi = 0$, negative interest rates are neither contractionary nor expansionary

Solving bank problem

- Bank profits: $\pi_t = \frac{i_t^b - i_t^s}{1+i_t^s} L_t - \frac{i_t^s - i_t^r}{1+i_t^s} R_t - \frac{i_t^s + \gamma}{1+i_t^s} M_t^b - \Gamma\left(\frac{L_t}{\bar{L}_t}, R_t, M_t^b, \pi_t\right)$
- Balance sheet constraint:
  $(1+i_t^s)D_t = \left(1+i_t^b\right)L_t + (1+i_t^r)R_t + (1-\gamma)M_t^b$
- First order condition for L_t: $\frac{i_t^b - i_t^s}{1+i_t^s} = \frac{1}{\bar{L}_t}\Gamma_L\left(\frac{L_t}{\bar{L}_t}, R_t, M_t^b, \pi_t\right)$
- First order condition for R_t: $-\Gamma_R\left(\frac{L_t}{\bar{L}_t}, R_t, M_t^b, \pi_t\right) = \frac{i_t^s - i_t^r}{1+i_t^s}$
- First order condition for M_t^b: $-\Gamma_M\left(\frac{L_t}{\bar{L}_t}, R_t, M_t^b, \pi_t\right) = \frac{i_t^s + \gamma}{1+i_t^s}$

Policy

- Central Bank controls base money $M_t + R_t$ and interest rate on reserves i^r
- Optimal policy as in Curdia and Woodford (2011): if possible, supply R_t such that banks are satiated and $\Gamma_R = 0$
  - Implies $i_t^s = i_t^r$ from first order condition
- Taylor rule: $i_t^r = r_t^n + \phi_\Pi \Pi_t + \phi_Y Y_t$
- Deposit rate: $i_t^s = max\{i_t^r, -\gamma\}$

Model summary

- Model can be summarized as NK model with endogenous natural rate of interest.

- $\hat{Y}_t = \mathbb{E}_t \hat{Y}_{t+1} - \sigma(\hat{\imath}_t^s - \mathbb{E}_t \hat{\Pi}_{t+1} - \hat{r}_t^n)$
  - $\hat{r}_t^n = -\zeta_t - \chi\hat{\omega}_t$
  - $\hat{\omega}_t = \frac{i^b - i^s}{1+i^b}\left((\nu - 1)\hat{B}_t^b - \nu\bar{b}_t + \iota\hat{\pi}_t\right)$

- $\hat{\Pi}_t = \kappa\hat{Y}_t + \beta\mathbb{E}_t\hat{\Pi}_{t+1}$

- $\hat{\imath}_t^r = \hat{r}_t^n + \phi_\Pi\hat{\Pi}_t + \phi_Y\hat{Y}_t$

- $i_t^s = max\{i_t^r, -\gamma\}$

Equilibrium

Calibration

- Solve log-linearized model using OccBin (Guerrieri and Iacoviello 2015)
  - occasionally binding constraint

Parameter	Value	Source/Target
Inverse of Frisch elasticity of labor supply	$\eta = 1$	Justiniano et.al (2015)
Share of borrowers	$\chi = 0.61$	Justiniano et.al (2015)
Steady-state gross inflation rate	$\Pi = 1$	For simplicity.
Discount factor, saver	$\beta^s = 0.9963$	Domeij and Ellingsen (2015)
Discount factor, borrower	$\beta^b = 0.99$	Annual borrowing rate of 4 %
Marginal intermediation cost parameters	$\nu = 6$	Target a debt/GDP ratio of 100 %
Probability of resetting price	$\alpha = 2/3$	Gali (2008)
Elasticity of substitution among varieties of goods	$\theta = 7.88$	Rotemberg and Woodford (1997)
Proportional storage cost of cash	$\gamma = 0.01$ %	Target effective lower bound $\underline{i}_t^s \approx 0$, but not $\underline{i}_t^s = 0$.
Reserve satiation point	$\overline{R} = 0.05$	Target steady-state reserves/total assets ratio of 13 %
Money satiation points	$\overline{M} = 0.01$	Target steady-state cash/total assets of 3 %
Taylor coefficient on inflation gap	$\phi_\Pi = 1.5$	Gali (2008)
Taylor coefficient on output gap	$\phi_Y = 0.5/4$	Gali (2008)
Link between profits and intermediation costs	$\iota = -0.015$	1 % increase in profits $\Rightarrow$1.5 % reduction in marginal cost of lending

Shock	Value	Source/Target
Preference shock	$\xi = 0.02$	Generate a 4.5 % drop in output on impact
Persistence of preference shock	$\rho = 0.85$	Duration of ZLB of 12 quarters

Table 3: Parameter values

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Model Experiments

- Are negative interest rates expansionary?

- Consider two shocks to the economy
  - Preference shock
  - Intermediation cost shock
  - Target an initial 4.5 percent drop in output. Duration of ZLB of 12 quarters.

1. Standard model
   - Reserve rate and deposit rate both bounded

2. No bound
   - No bounds on any interest rate

3. Negative Rates
   - Only deposit rate is bounded

Preference shock

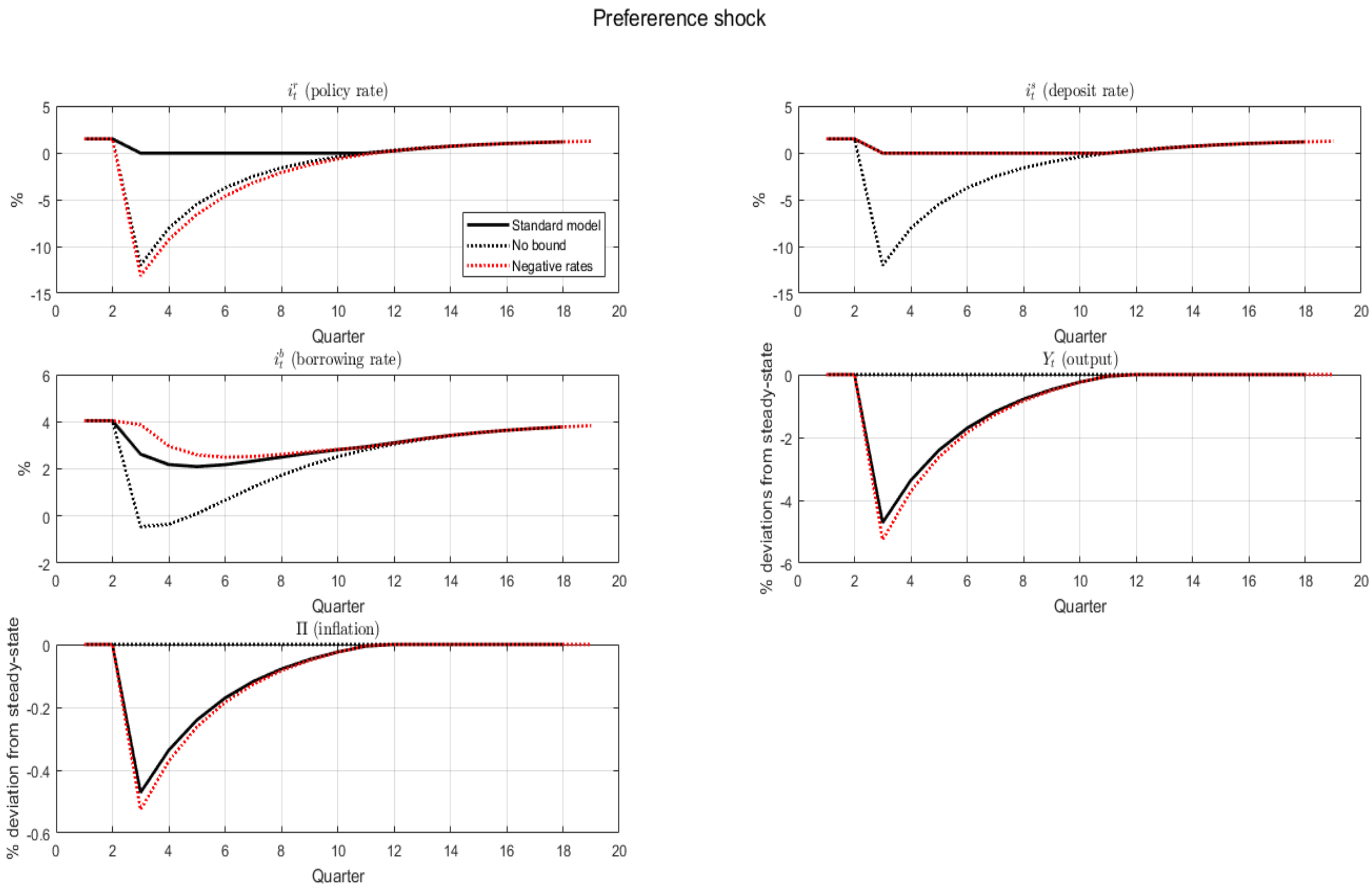
- Frictionless case ("No bound")
  - CB reacts to fall in aggregate demand by reducing i^r (below zero)
  - Deposit rate i^s falls one-to-one with i^r
  - Savers react by increasing consumption C^s
  - Financing cost falls, which increases loan supply and thereby C^b
  - Result: no reduction in aggregate demand or inflation

- With bounds on i^r and i^s ("Standard model")
  - CB lowers i^r to zero, and i^s follows one-to-one
  - Interest rate reduction insufficient to counteract negative shock
  - Result: aggregate demand and inflation falls

Preference Shock

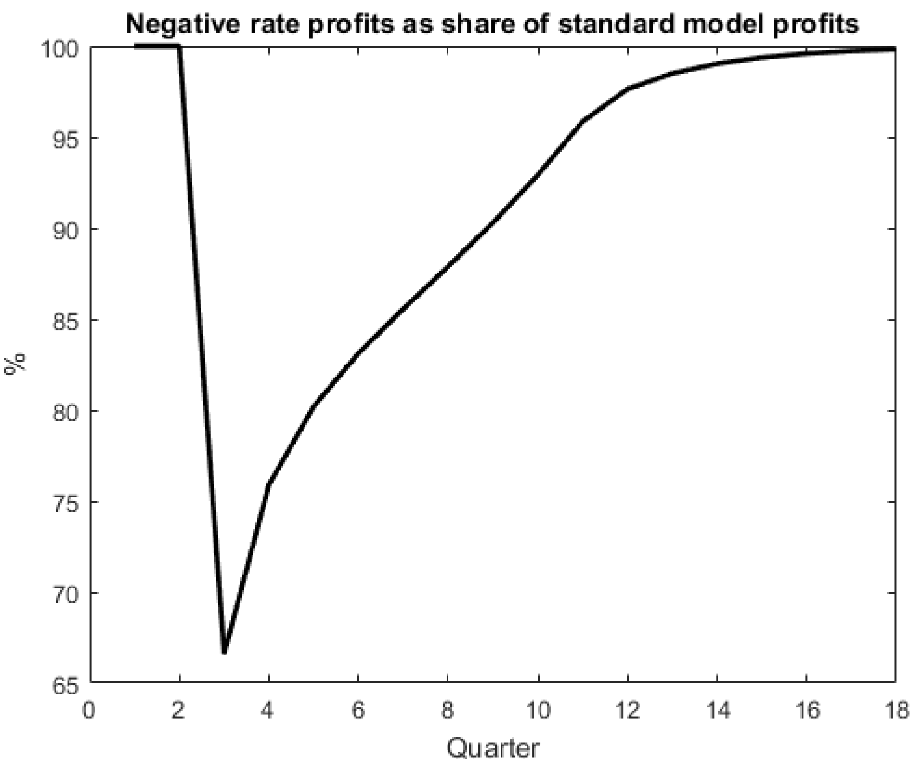
- What if i^s is bounded, but i^r is not?
  - Post-great-recession world
- "Negative Rates" scenario:
  - CB reacts to fall in aggregate demand by reducing i^r
  - Deposit rate i^s follows one-for-one until it reaches zero
  - The small reduction in i^s is insufficient to counteract negative shock
  - Result: aggregate demand and inflation falls
- Identical to the standard model? Not quite...
  - The gap between i^r and i^s reduces bank profits
  - This increases intermediation costs and lowers credit supply
- Going negative is not expansionary – if anything it is contractionary

Preference Shock



Profits lower with negative rates

- “Negative rates starting to weigh on banks’ profits” (Financial Times 2016)
- “To date, the effect negative interest rates have had on bank profits have put downward pressure on the majority of bank stocks,…” (Charles Kane 2016, MIT Sloan School of Management)
- “Negative Interest Rates: A Tax in Sheep's Clothing” (Christopher J. Waller 2016, St. Louis FED)



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Summary

- Empirically: negative central bank rates have limited pass-through to deposit rates and lending rates
- The bound on the deposit rate causes lending rates to be bounded as well
  - Banks hold their interest rate margin constant
- Lowering the policy rate below the bound on deposit rates does not reduce the interest rates faced by households
  - Negative rates are not expansionary
- Lowering the policy rate below the bound on deposit rates reduces bank profits
  - Negative rates are contractionary

Discussion

- Alternative funding source could mitigate negative impact on profits
  - Differential pass-through of negative policy rate to other interest rates
  - Sweden: deposits make up more than 40% of liabilities – has increased since 2015
  - Deposit share in the Euro Area generally higher than in Sweden
- Alternative transmission mechanism
  - Exchange rates (Denmark, Switzerland)
  - Increased risk taking
    - Heider et al (2017): no difference in total lending, but higher risk taking – desirable?
- Higher bank fees could lower efficient deposit rate below zero
  - Commision income quantitatively small
  - No increase in fees and commission income for Swedish banks
- Fixed costs of shifting from reserves to money
  - Expectations about future policy matter

Deposit share Bank Fees

Extras

Household first-order conditions

- Euler equation
  - $u_C{}'(C_t^j, M_t^j, N_t^j)\zeta_t = \beta^j(1 + i_t^j)E(\Pi_{t+1}^{-1} u_C{}'(C_t^j, M_t^j, N_t^j)\zeta_{t+1})$
- Money demand
  - $\frac{u_M{}'\left(C_t^j, M_t^j, N_t^j\right)}{u_C{}'\left(C_t^j, M_t^j, N_t^j\right)} = \frac{1+\gamma}{P_t}$
- Labor supply
  - $-\frac{u_N{}'\left(C_t^j, M_t^j, N_t^j\right)}{u_C{}'\left(C_t^j, M_t^j, N_t^j\right)} = \frac{W_t^j}{P_t}$

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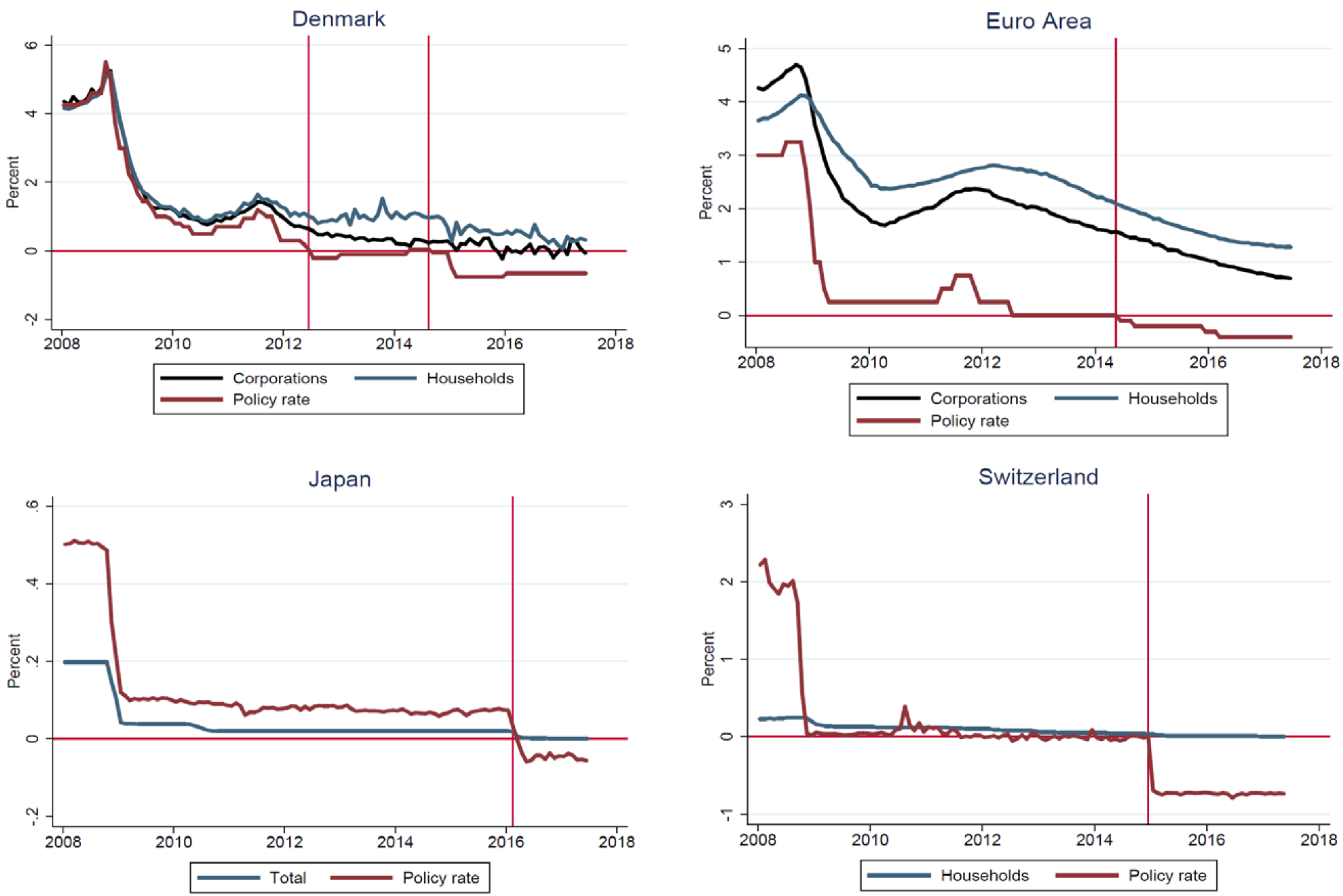
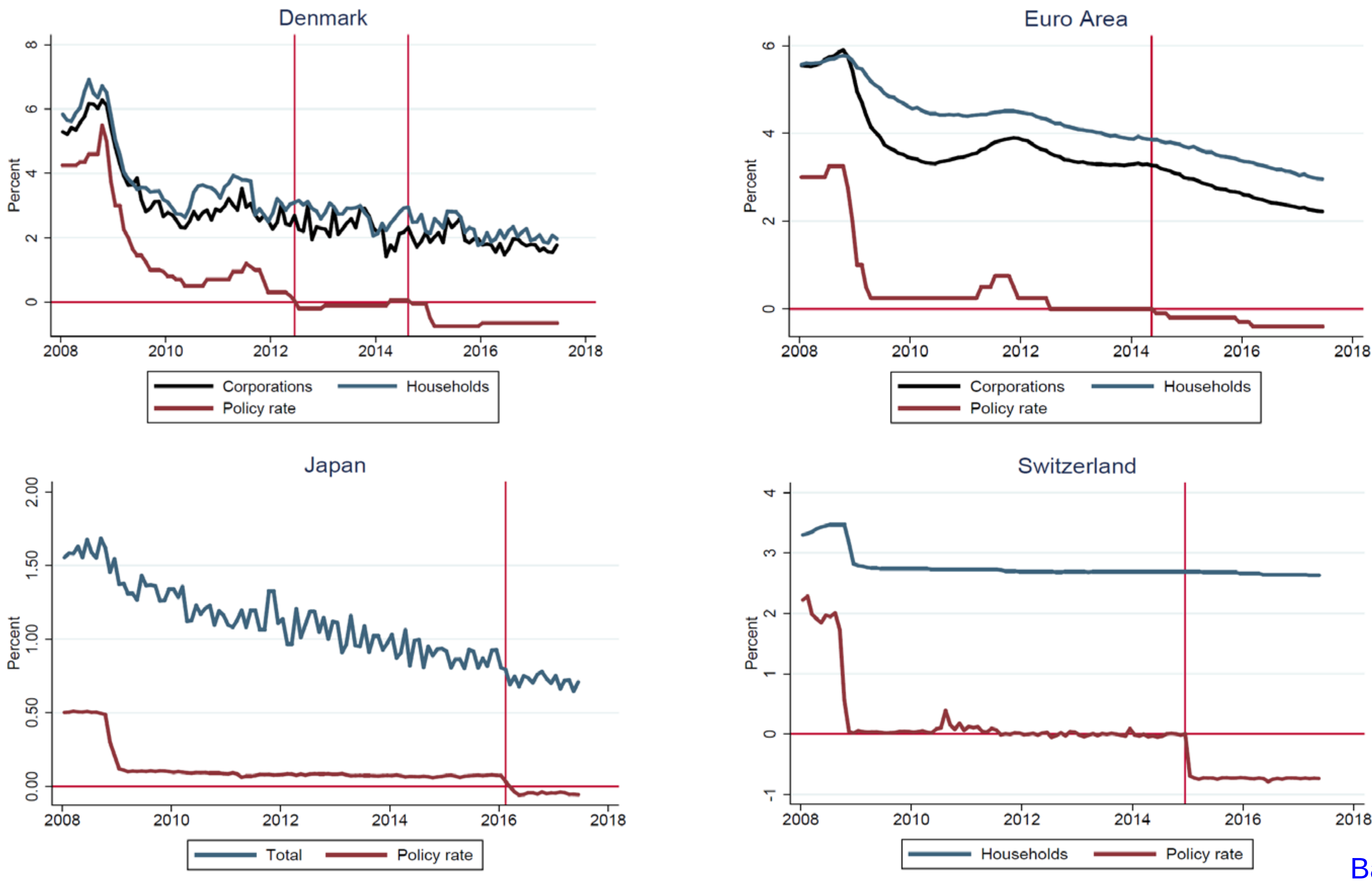
Deposit rates



Back

Lending rates



Back

Deposit shares and lending volumes

- Heider et al (2017): Euro Area banks with higher deposit shares have lower lending growth post-zero
- Confirm that the results in Heider et al (2017) also holds for Swedish banks
  - Difference in difference analysis
- $\Delta \log(Lending_{it}) = \alpha + \beta I_t^{post} \times DepositShare_i + \delta_i + \delta_t + \epsilon_{it}$
- Result: $\hat{\beta} = -0.0297^*$
- Post-zero, banks with high deposit shares have lower lending growth than banks with low deposit shares – relative to the pre-zero period

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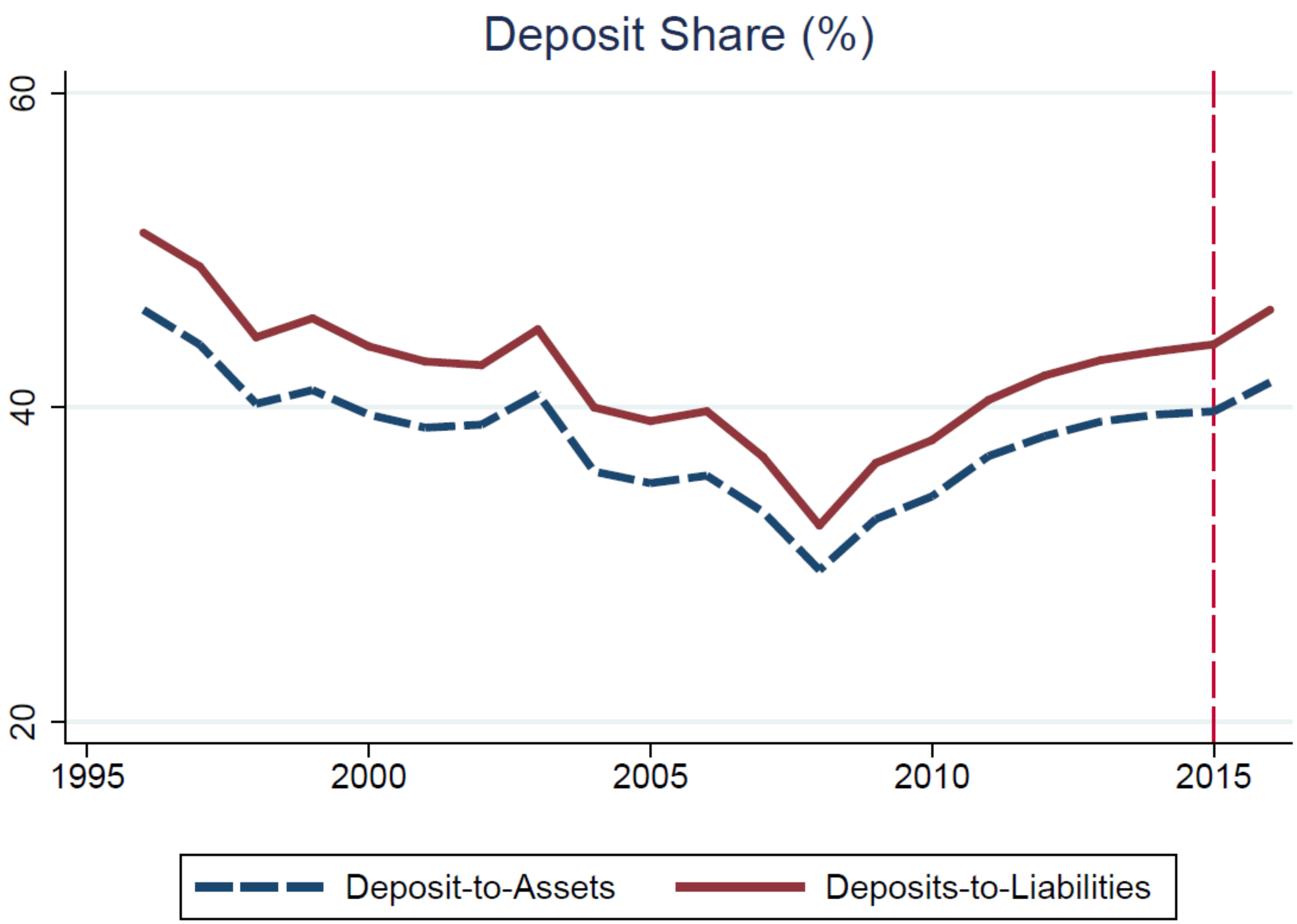
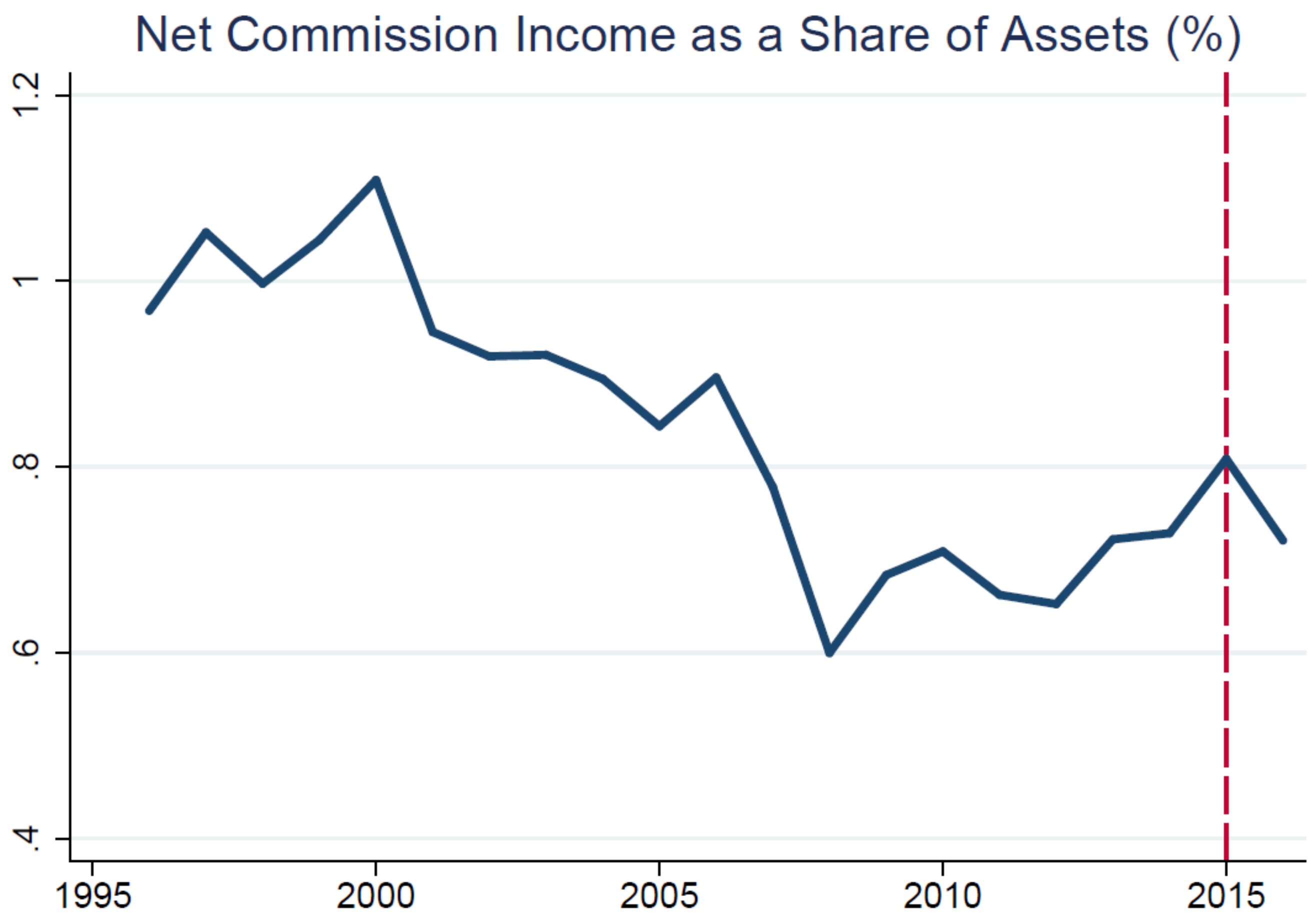
Deposit share Sweden



Back

Bank fees Sweden



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Log-Linear Equilibrium Conditions

$\left\{\widehat{C_t^b}, \widehat{B_t^b}, \widehat{Y}_t, \widehat{\Pi}_t, \widehat{r_t^n}, \widehat{M}_t, \widehat{\pi}_t, \widehat{i_t^r}, \widehat{i_t^s}, \widehat{i_t^b}, \widehat{\omega}_t\right\}_{t=0}^{\infty}$ *such that the following 11 equations hold:*

- $\widehat{Y}_t = \mathbb{E}_t\widehat{Y}_{t+1} - \sigma\left(\hat{\imath}_t^s - \mathbb{E}_t\widehat{\Pi}_{t+1} - \hat{r}_t^n\right)$
- $\hat{r}_t^n = -\zeta_t - \chi\widehat{\omega}_t$
- $\hat{C}_t^b = \hat{C}_{t+1}^b - \frac{1}{zC^b}\left(\hat{\imath}_t^b - \mathbb{E}_t\widehat{\Pi}_{t+1} + \widehat{\zeta}_t\right)$
- $C^b\widehat{\Pi}_t + C^b\hat{C}_t^b = \widehat{\Pi}_t\left(\chi Y + B^b\right) + \chi Y\widehat{Y}_t + B^b\widehat{B}_t^b - B^b\hat{\imath}_t^b - B^b(1+i^b)\widehat{B}_{t-1}^b$
- $\widehat{\Pi}_t = \kappa\widehat{Y}_t + \beta\mathbb{E}_t\widehat{\Pi}_{t+1}$
- $\hat{\imath}_t^s + \hat{\pi}_t = \frac{\chi B^b}{(1+i^s)\pi}\left((1+i^b)\hat{\imath}_t^b - (1+i^s)\hat{\imath}_t^s + \left(i^b - i^s\right)\widehat{B}_t^b\right) + \frac{R}{(1+i^s)\pi}\left((1+i^r)\hat{\imath}_t^r - (1+i^s)\hat{\imath}_t^s\right) - \frac{M}{(1+i^s)\pi}\left((1+i^s)\hat{\imath}_t^s + (i^s + \gamma + M - \bar{M})\widehat{M}_t\right) + \frac{(M-\bar{M})^2}{2\pi}\hat{\imath}_t^s + \pi^{\iota-1}\left(\nu(\widehat{\bar{B}}_t^b - \widehat{B}_t^b) - \iota\hat{\pi}_t - \hat{\imath}_t^s\right)$
- $\hat{\imath}_t^b - \hat{\imath}_t^s = \widehat{\omega}_t$
- $\widehat{\omega}_t = (i^b - i^s)\left((\nu - 1)\widehat{B}_t^b - \nu\widehat{\bar{B}}_t^b + \iota\hat{\pi}_t\right)$
- $\hat{\imath}_t^s = \hat{\imath}_t^r$
- $\widehat{M}_t = \frac{M-\bar{M}}{M}\frac{i^s+\gamma-1}{i^s+\gamma}\hat{\imath}_t^s$
- $\hat{\imath}_t^r = \hat{r}_t^n + \phi_\Pi\widehat{\Pi}_t + \phi_Y\widehat{Y}_t$

Back