The bank lending channel in Switzerland: Capturing cross-section heterogeneity and asymmetry over time

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Research seminar

WU Wien, 10 May 2019

The presented views are personal and do not necessarily reflect those of the SNB

Motivation

- Monetary policy affects the economy through various channels
- Most (forecasting) models incorporate the exchange rate channel (important in the case of a small open economy) and the direct interest rate channel
- The credit view, and in particular the bank lending channel, is often missing. Is this justified?
- There is no recent study on the bank lending channel for Switzerland:
  - Long observation period 1987-2016 (quarterly data)
  - Several business cycles, financial markets liberalization
  - Financial crisis
  - Zero lower bound, minimum EURCHF exchange rate, negative interest rates

Literature

Theory and international evidence

- Credit view: Bernanke and Blinder (1988, 1992)
- Bank lending channel: Kashyap and Stein (1995, 2000, US), De Bondt (1999, EU)
  - Angeloni, Kashyap and Mojon (editors, 2003, Euro area)
  - Asymmetric lending reaction: Frühwirth-Schnatter and Kaufmann (2006, AT)
  - Impact of economic uncertainty: Alessandri and Bottero (2017)
  - Role of globalization: Denderski and Paczos (2017) on foreign banks, Cao and Dinger (2018) and Lindner et al. (2018) on international funding

Studies with Swiss data

- VAR analysis: Steudler and Zurlinden (1998) do not find evidence for the bank lending channel, Natal (2002, 2003) finds evidence for the credit channel
- Panel analysis: Perrez and Bichsel (2003) find (not very robust) evidence for the bank lending channel
- Survey: Zurlinden (2005)

This paper

Substantially updated and extended version of unpublished research (Amstad and Kaufmann, 2003)
$\rightarrow$ unbalanced panel estimation

Baseline model taken from Frühwirth-Schnatter and Kaufmann (2006, JAE):

- Do interest rate changes affect bank lending in Switzerland?
- Is there evidence for a bank lending channel: Heterogeneous effects across banks of different size, liquidity or/and equity share, etc.?
  $\rightarrow$ Agnostic view: clustering/grouping of banks is part of model estimation
- Are banks' lending responses asymmetric over time: Period-specific effect of monetary policy?
  $\rightarrow$ Agnostic view: period-specific effects also part of model estimation

We investigate Swiss bank-individual loan data over 30 years: 1987Q1 – 2016Q4

Dependent variable: Growth rate of bank-individual domestic loans

(clients and mortgages)

- Minimum length of continuous reporting: 8 quarters
  $\rightarrow$ 645 of 890 banks drop out (too small or no mandatory reporting)
- Missing data or outliers (merger and acquisitions, statistical, large negative growth rate pre-merger or -dissolution)
- Substitute model-based estimate for outliers:
  $\rightarrow$ no more than 8 continuous quarters of missing data or outliers (drop observations otherwise)
  $\rightarrow$ drop missing/outliers or banks if there are too many missing values or outliers
  $\rightarrow$ drop large negative growth rate pre-merger or -dissolution

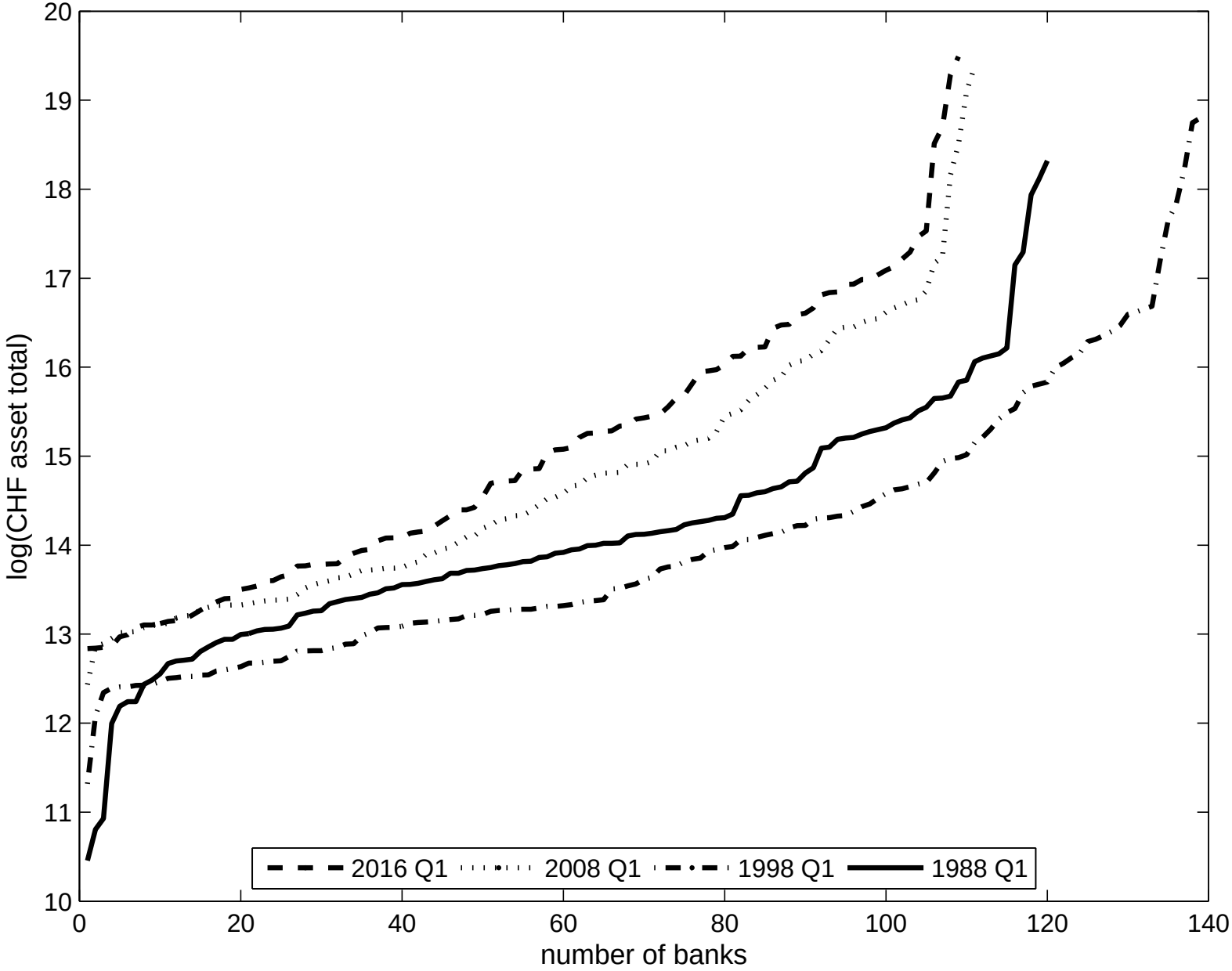
This leaves us with 241 banks (13,600 observations):

- 40 observed over the whole sample period
- 80 disappear due to merger, acquisition or dissolution
- 67 banks start business at some point
- 54 report intermittently

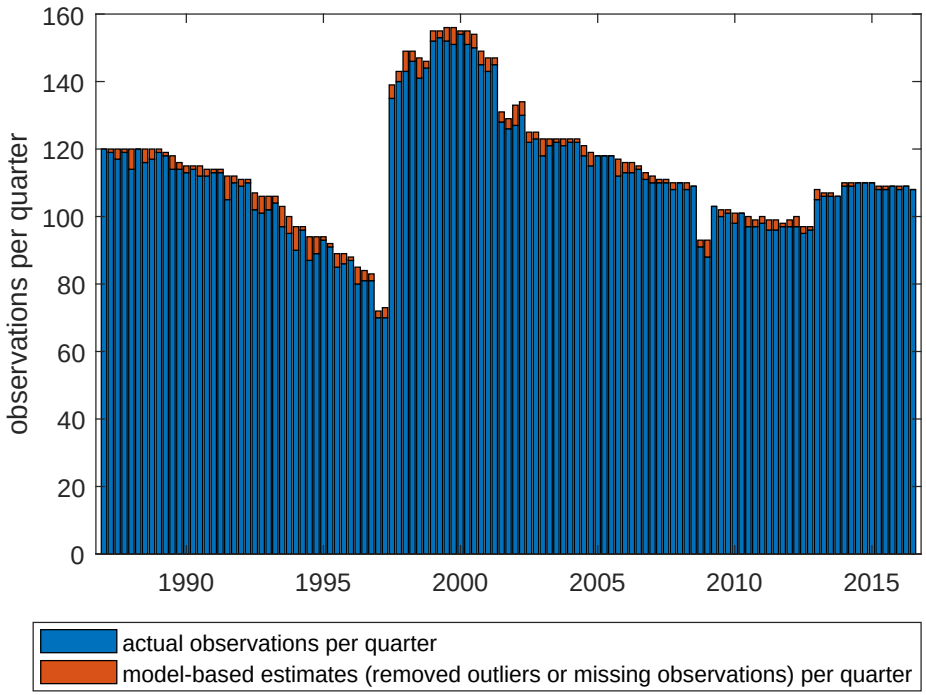
Summary statistics (in million CHF), 2016Q1

	Total	Absolute size		Relative size	
		largest 15 banks	smallest 15 banks	above 90th percentile	below 50th percentile
Number of banks	109	15	15	11	54
CHF asset total	1,482,272	1,085,061	7017	992,329	56,758
Market share		73.2	0.5	66.9	3.8
Average size	13,599	72,337	468	90,212	1,051
Average liquidity share	20.2	18.9	6.9	21.2	18.0
Domestic loans (market share)	909,611	71.5	0.7	63.2	4.6
Average loan share	61.4	60.0	89.1	57.9	73.3

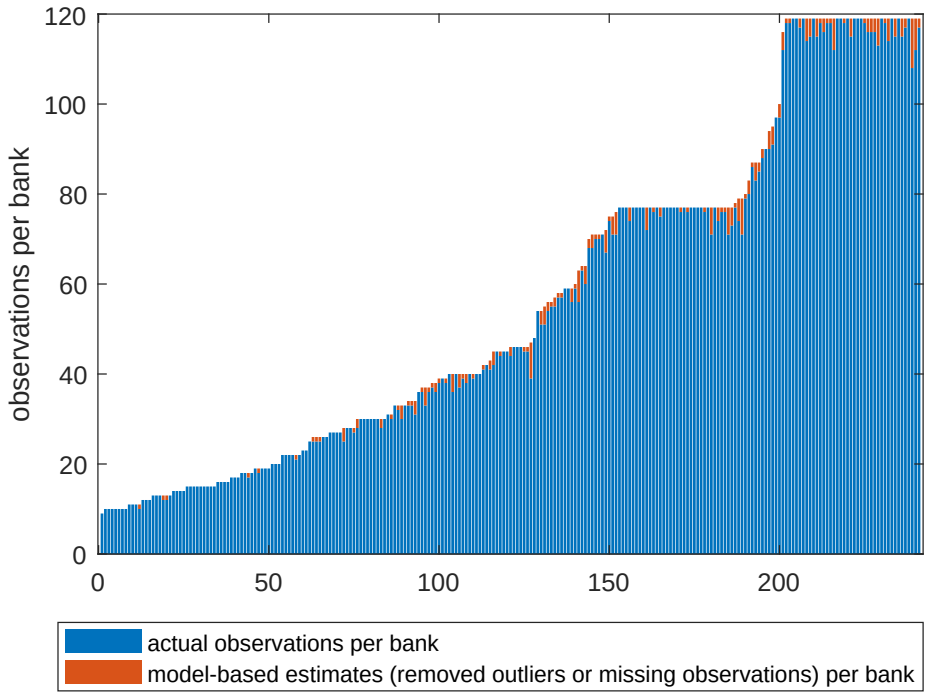
Empirical size distribution in four different quarters



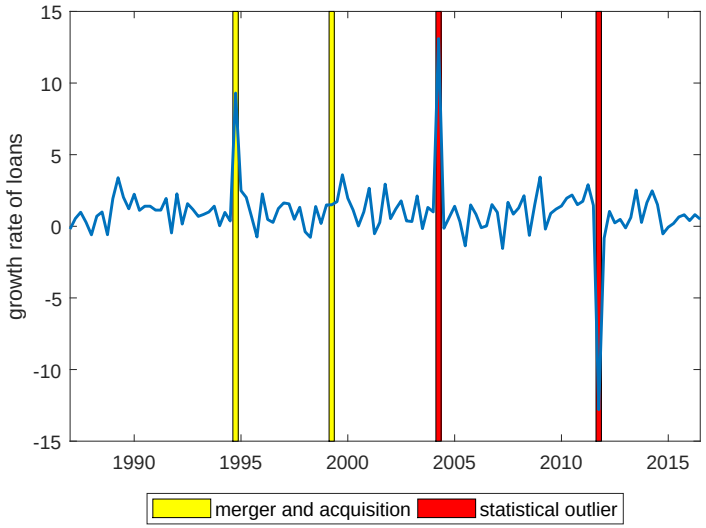
Actual observations and model-based estimates



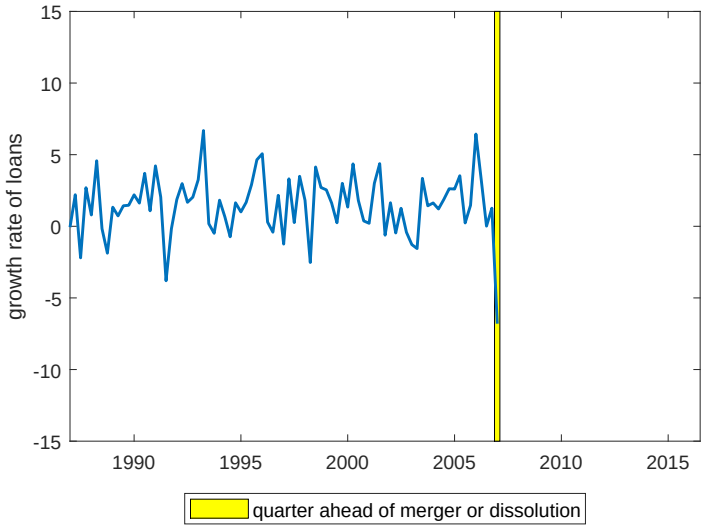
(a) Per quarter



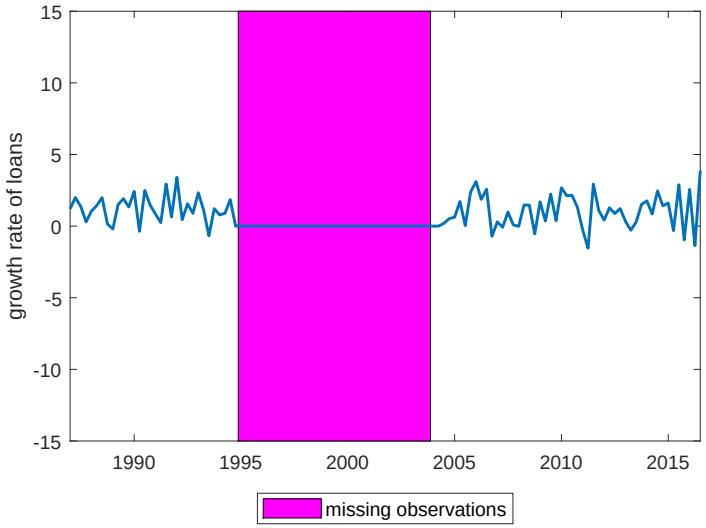
(b) Per bank



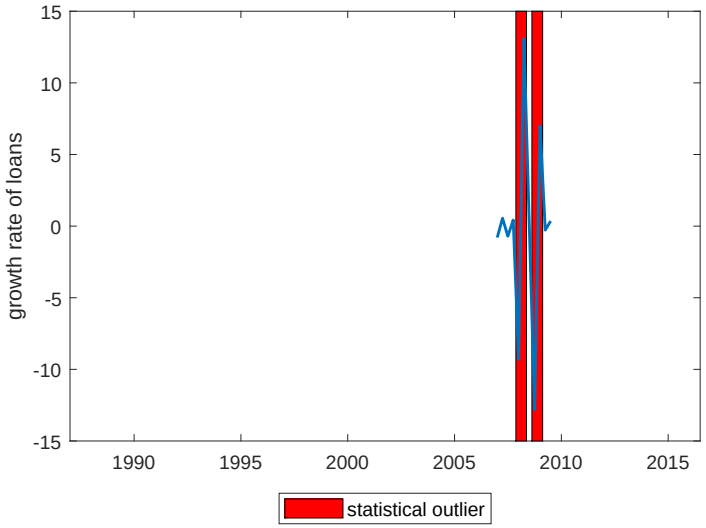
(a) M&A, statistical outliers



(b) Large negative pre-merger or -dissolution



(c) Missing values



(d) Too many outliers relative to observed values

Econometric model

$$y_{it_i} = \sum_{j=0}^{q} \beta_{I_{t_i},j}^{S_i} x_{t_i-j} + \sum_{j=1}^{p} \phi_{I_{t_i},j}^{S_i} y_{i,t_i-j} + \sum_{j=1}^{m} \alpha_j \mathrm{X}_{jt_i} + \alpha_0 + \varepsilon_{it_i}$$

$$\varepsilon_{it_i}|\lambda_i \sim N(0, \sigma^2/\lambda_i),\ i = 1, \ldots, N$$

$$t_i \in \tau_i, \tau_i = \{j | j \in \{1, \ldots, T\}\,; (y_{ij}, y_{i,j-1}, \ldots, y_{i,j-p}) \text{ all observed}\}$$

- y_{it_i}: growth rate in loans, bank i in period t_i, $T_i = \sum_{j=1}^{T} \delta\{j \in \tau_i\}$, with $\delta\{E\} = 1$ if E true
  x_{t_i-j}: change in 3M CHF Libor lagged j periods
  X_{jt_i}: control variable j in period t_i
- Bank-specific error volatility $\sigma_i^2 = \sigma^2/\lambda_i \rightarrow$ captures cross-section heteroskedasticity

$$y_{it_i} = \sum_{j=0}^{q} \beta^{S_i}_{I_{t_i},j} x_{t_i-j} + \sum_{j=1}^{p} \phi^{S_i}_{I_{t_i},j} y_{i,t_i-j} + \sum_{j=1}^{m} \alpha_j \mathrm{X}_{jt_i} + \alpha_0 + \varepsilon_{it_i}$$

- Individual bank lending reaction is pooled into groups with time-specific effects:
  - Group-indicator $S_i = \{1 \ldots G\}$ is latent (estimated)
    $\rightarrow$ cluster heterogeneous effects across banks into groups

$$P(S_i = g) = \eta_g,\ g = 1, \ldots, G,\ \sum_{g=1}^{G} = \eta_g = 1$$

  - State-indicator $I_t = \{1 \ldots K\}$ is latent (estimated) $\rightarrow$ time-specific effects within a group

$$P(I_t = k | I_{t-1} = j) = \xi_{jk},\ j, k = 1, \ldots, K,\ \sum_{k=1}^{K} \xi_{jk} = 1$$

$$\beta^{S_i}_{I_t,j} = \beta^{g}_{k,j},\ \phi^{S_i}_{I_t,j} = \phi^{g}_{k,j},\ \text{ if } S_i = g \text{ and } I_t = k$$

Bayesian MCMC estimation

Collect model parameters in $\boldsymbol{\theta} = \{\boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\phi}, \sigma, \boldsymbol{\lambda}, \boldsymbol{\eta}, \boldsymbol{\xi}\}$
Extended parameter vector $\boldsymbol{\vartheta} = \{\boldsymbol{\theta}, \boldsymbol{S}, \boldsymbol{I}\}$, with $\boldsymbol{S} = (S_1, \ldots, S_N)$ and $\boldsymbol{I} = (I_1, \ldots, I_T)$.

$$\underbrace{\pi\left(\boldsymbol{\vartheta}|\mathbf{Y}, \mathbf{X}\right)}_{\text{posterior}} \propto \underbrace{L\left(\mathbf{Y}|\mathbf{X}, \boldsymbol{\vartheta}\right)}_{\text{likelihood}} \underbrace{\pi\left(\boldsymbol{I}|\boldsymbol{\xi}\right)\pi\left(\boldsymbol{S}|\boldsymbol{\eta}\right)\pi\left(\boldsymbol{\theta}\right)}_{\text{prior}}$$

Prior on latent variables and parameters:

$$\pi\left(\boldsymbol{S}|\boldsymbol{\eta}\right),\ \pi\left(\boldsymbol{I}|\boldsymbol{\xi}\right),\ \pi\left(\boldsymbol{\theta}\right) = \pi\left(\boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\phi}\right)\pi\left(\sigma\right)\pi\left(\boldsymbol{\lambda}\right)\pi\left(\boldsymbol{\eta}\right)\pi\left(\boldsymbol{\xi}\right)$$

Sample from the posterior:

- $\pi\left(\boldsymbol{S}|\mathbf{Y}, \mathbf{X}, \boldsymbol{I}, \boldsymbol{\theta}\right) \propto L\left(\mathbf{Y}|\mathbf{X}, \boldsymbol{I}, \boldsymbol{S}, \boldsymbol{\theta}\right)\pi\left(\boldsymbol{S}|\boldsymbol{\eta}\right)$ and update $\pi\left(\boldsymbol{\eta}|\boldsymbol{S}\right)$
- $\pi\left(\boldsymbol{I}|\mathbf{Y}, \mathbf{X}, \boldsymbol{S}, \boldsymbol{\theta}\right) \propto L\left(\mathbf{Y}|\mathbf{X}, \boldsymbol{I}, \boldsymbol{S}, \boldsymbol{\theta}\right)\pi\left(\boldsymbol{I}|\boldsymbol{\xi}\right)$ and update $\pi\left(\boldsymbol{\xi}|\boldsymbol{I}\right)$
- $\pi\left(\boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\phi}|\mathbf{Y}, \mathbf{X}, \boldsymbol{S}, \boldsymbol{I}, \sigma, \boldsymbol{\lambda}\right)$
- $\pi\left(\sigma|\mathbf{Y}, \mathbf{X}, \boldsymbol{S}, \boldsymbol{I}, \boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\phi}, \boldsymbol{\lambda}\right), \pi\left(\boldsymbol{\lambda}|\mathbf{Y}, \mathbf{X}, \boldsymbol{S}, \boldsymbol{I}, \boldsymbol{\beta}, \boldsymbol{\alpha}, \boldsymbol{\phi}, \sigma\right)$
- $\pi\left(\tilde{\boldsymbol{Y}}|\mathbf{Y}_{\_\tilde{\boldsymbol{Y}}}, \mathbf{X}, \boldsymbol{\vartheta}\right)$ (missing or outlying values)
- Random permutation of groups and states $\rightarrow$ uncover group- and state-specific effects

Results: Baseline specification

Dependent Variable:	State 1		State 2	
Δ loans$_t$	Group 1	Group 2	Group 1	Group 2
Δ 3M Libor$_t$	-0.10	-0.27	0.63	0.39
	(-0.49 0.28)	(-0.44 -0.11)	(0.19 1.14)	(0.19 0.60)
Δ 3M Libor$_{t-1}$	-0.38	-0.45	0.24	0.14
	(-0.81 0.11)	(-0.62 -0.24)	(-0.19 0.70)	(0.00 0.28)
sum	-0.48	-0.72	0.87	0.53
	(-1.01 0.06)	(-0.91 -0.52)	(0.34 1.44)	(0.38 0.69)
Δ loans$_{t-1}$	-0.20	0.22	-0.11	0.33
	(-0.25 -0.14)	(0.17 0.26)	(-0.18 -0.04)	(0.29 0.37)
long-run effect	-0.40	-0.92	0.78	0.79
	(-0.86 0.04)	(-1.16 -0.67)	(0.28 1.27)	(0.57 1.01)
$\xi_{11} \mid \xi_{22}$	0.78		0.67	
	(0.65 0.90)		(0.49 0.86)	
$\xi_{12} \mid \xi_{21}$	0.33		0.22	
	(0.14 0.51)		(0.10 0.35)	
inflation	0.06			
	(-0.02 0.15)			
output gap	0.05			
	(0.03 0.08)			
Δ term spread	-0.15			
	(-0.28 -0.01)			
Δ immigration	0.07			
	(0.04 0.10)			
economic uncertainty	-0.06			
	(-0.12 -0.02)			
constant	0.65			
	(0.58 0.72)			
number of banks	82	159		

Control variables:

inflation	q-o-q Swiss CPI inflation
output gap	Cobb-Douglas production function approach
term spread	difference 10-years government bond and 3M Libor
immigration	permanent foreign resident population
economic uncertainty	Theil disagreement (KOF)

Group-specific key balance sheet figures (median)

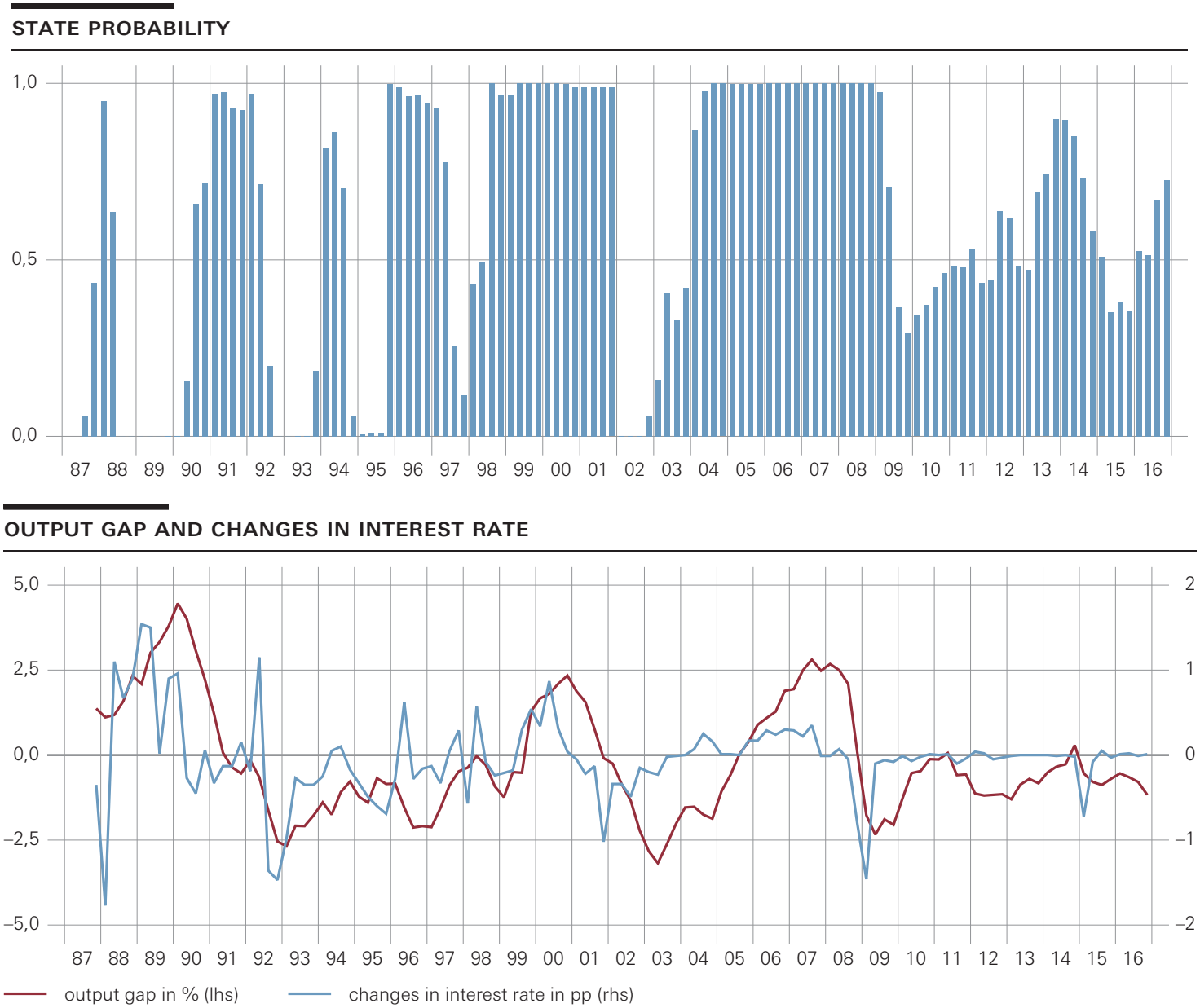
Across states:

Variables/Groups	Group 1	Group 2	G1/G2
CHF broad liquidity / CHF asset total	0.20	0.05	3.93
book equity / CHF asset total	0.06	0.04	1.34
CHF core deposits / CHF asset total	0.27	0.57	0.48
net interest income / total earnings	0.27	0.79	0.35
domestic loans / CHF asset total	0.26	0.63	0.40

State-specific:

Variables/Groups	Group 1		Group 2	
States	State 1	State 2	State 1	State 2
CHF broad liquidity / asset total	0.20	0.20	0.05	0.05
CHF illiquid assets / asset total	0.96	0.96	0.98	0.98
book equity / asset total	0.06	0.06	0.05	0.04

State probabilities, aggregate series



State-specific macro fundamentals

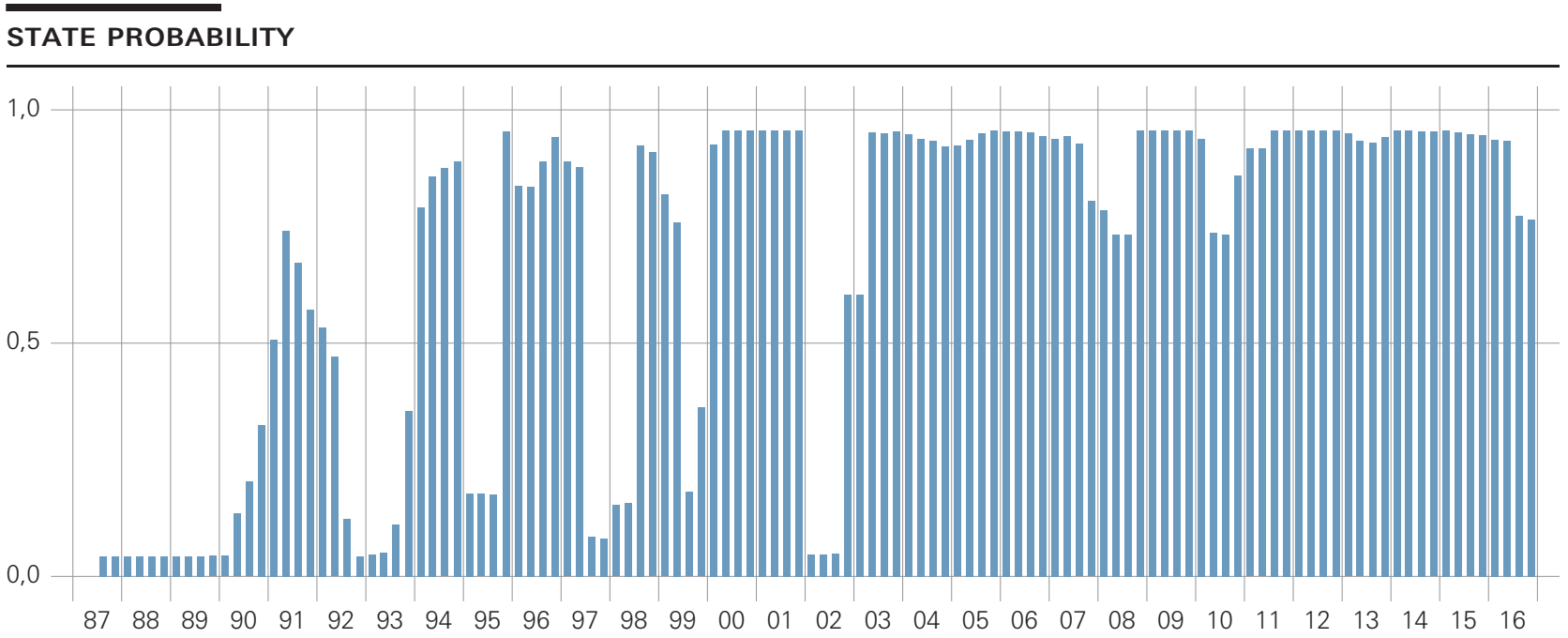
Macro Variables	State 1	State 2	*State 2**
Δ 3M Libor	-0.03	-0.05	*-0.22*
inflation	0.29	0.35	*0.20*
output gap	0.02	-0.43	*-1.27*
Δ term spread	0.01	-0.00	*0.09*
Δ immigration	2.44	2.60	*2.37*
uncertainty index	0.31	0.24	*0.69*

*excluding all state 2 periods before Q2 1990 (house price boom)

Looking closer to economic uncertainty

coeff.	$I_t = 1$		$I_t = 2$	
	β^1	β^2	β^1	β^2
Δ 3M Libor$_t$	0.23	-0.04	0.37	0.18
	(-0.19 0.66)	(-0.21 0.13)	(0.00 0.68)	(0.08 0.28)
Δ 3M Libor$_{t-1}$	-0.07	-0.21	-0.01	-0.03
	(-0.44 0.33)	(-0.39 -0.00)	(-0.32 0.28)	(-0.13 0.11)
sum	0.16	-0.26	0.35	0.15
	(-0.43 0.71)	(-0.51 0.00)	(-0.09 0.81)	(-0.00 0.33)
Δ loans$_{t-1}$	-0.17	0.25	-0.13	0.30
	(-0.23 -0.12)	(0.21 0.29)	(-0.20 -0.06)	(0.26 0.34)
long-run effect	0.13	-0.34	0.31	0.21
	(-0.35 0.62)	(-0.71 -0.03)	(-0.09 0.71)	(-0.01 0.47)
uncertainty index	0.23	0.03	-0.67	-0.47
	(-0.04 0.56)	(-0.03 0.15)	(-1.15 -0.27)	(-0.61 -0.35)
ξ	0.85	0.15		
	(0.72 0.95)	(0.05 0.28)		
	0.27	0.73		
	(0.09 0.45)	(0.55 0.91)		
inflation	0.08			
	(-0.00 0.16)			
output gap	0.04			
	(0.01 0.07)			
Δ immigration	0.06			
	(0.03 0.09)			
constant	0.59			
	(0.51 0.67)			
number of banks	82	159		

Looking closer at economic uncertainty: State probabilities



Additional robustness analysis

- Model with $G = 3$, three groups:
  Group 1 splits into two groups
- Restrict the sample to 1987Q2-2007Q3: Exclude the financial crisis
- Include inflation and output gap as only controls
- Include banks with market share larger than 0.35 (48 banks)
  $G = 1$, homogenous group

$\rightarrow$ Main results unchanged

Conclusions

- Do interest rate changes affect bank lending in Switzerland? Yes
- Is there evidence for a bank lending channel: Heterogeneous effects across banks of different size, liquidity or/and equity share, etc.? Yes. We find stronger effects for banks that are less liquid, are less well capitalized, more strongly deposit-financed and more exposed to the domestic loan market.
- Are banks' lending responses asymmetric over time: Period-specific effect of monetary policy? Yes. Bank lending responds
  negatively during "normal "times,
  positively when interest rate strongly decrease (economic conditions deteriorate)
- Possible explanations for the latter, puzzling result:
  - effect of economic uncertainty (Alessandri and Bottero, 2017)
  - reversal of interest rate effect (Brunnermeier and Kobi, 2017)